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SOME REFLECTIONS UPON THE REACTION FROM COEDUCATION.

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THE authorities of many of our great coeducational universities have been of late much perplexed and depressed at the astonishing number of young women who insist on patronizing these institutions. Taken in moderation the coeducational young woman has succeeded in approving herself to a considerable majority of her instructors. But she has recently shown a disposition to outnumber the young men in her classes, and this is resented by certain of her mentors as an obvious impropriety. The occasion has been seized upon by reactionaries here and there to magnify the drawbacks of coeducation, and there can be no question that many members of the faculties of institutions committed to this system are restive under the extant conditions, and apprehensive for the future. A few, especially certain of those educated in eastern non-coeducational institutions or in foreign universities, are severely, not to say bitterly, critical in their attitude, and eager for anything so it be a change. We may therefore expect in the near future much experimentation, and more discussion, upon the coeducational program. As a symptom of the educational development of the country at large, the present agitation possesses an interest and significance quite beyond the limits of the regions immediately affected.

In order to see the present situation in its just perspective one must bear in mind the remarkable educational development which has occurred in recent years in those parts of the country where coeducation

is indigenous. The decade from 1890 to 1900 witnessed a growth wholly unprecedented in most of the strong coeducational colleges and universities of the central and western states. Academic standards were raised, equipments were lavishly provided in accordance with modern demands, faculties were enlarged and admirably trained specialists were secured in every department. In many institutions graduate courses of high merit were developed. The increase in the number of students was equally remarkable. The University of Minnesota leaped from 1,183 to over 3,000. The University of California from 763 to 3,024. The University of Wisconsin rose from 966 to 2,619. Cornell had 1,390 students in 1890, and 2,458 in 1900. At the University of Michigan the figures for the same period were 2,420 and 3,482. Moreover, in this same decade two coeducational universities were founded, Leland Stanford, Jr., University and the University of Chicago, which at once took rank with the foremost institutions of the country. In the year 1900 the former reported 1,389 students, the latter 3,520. Many other universities might be cited, such as the State Universities of Iowa, Ohio, Missouri, Kansas, Nebraska and Illinois, but they all tell the same story of the tropical development of higher education throughout this central and western region.

In 1890 there was but one of the large coeducational colleges in which women constituted over a third of the student body. This was true even in the courses grouped under the departments of literature, science and the arts. In institutions possessing schools of law and medicine the percentage of women in the total student body was very small. Even at this early date, however, Oberlin College was enjoying the fruits of its pioneer policy in first opening the doors of a man's college to women by finding 53 per cent. of its students women. It is not without interest to those nervous prophets who foresee a tidal wave of women sweeping the helpless men before it out of the coeducational institutions, that the percentage of women in the department of liberal arts at Oberlin has remained almost stationary for ten years, having, as a matter of fact, fallen somewhat toward the end of the period. Oberlin is in this particular also an exception, however. In all the other important universities the percentage of women has materially increased, and in some instances passed the fifty-per-cent. mark. Thus in 1900 the course in literature, arts and general science showed at the University of California 55 per cent. women; at Minnesota 53 per cent.; at Chicago 47 per cent.; at Michigan 47 per cent; and at Northwestern 44 per cent.*

* These figures cannot be regarded as absolutely accurate, owing to the method of cataloguing found in the reports of certain institutions. The pe-

If professional schools are included in the computations, the figures take on a very different complexion. Thus at Michigan, for instance, in 1900 the law school with nearly 900 male students and the medical departments with over 600 served, together with the engineering school of 350, to keep the proportion of women to men in the whole institution within 3 per cent. of what it was in 1890, the figures being 16 per cent. and 19 per cent. for the beginning and end of the decade respectively. In almost every case the increase in the percentage of women occurred in the face of an unparalleled increase in the number of male students. Indeed, a recent writer has presented statistics to prove that the increase in the number of men in coeducational institutions has for some years past been relatively more rapid than the increase in the colleges for men alone. This, too, is a hard saying for those who maintain that women are driving men out of the coeducational institutions. But it does not mean, as we shall presently see, that women and men are increasing with equal rapidity in the same courses of study.

One finds his natural anticipations fulfilled in the almost entire absence of women from the courses in law and technology. Medicine attracts a small quota, but to all intents and purposes the serious embarrassments of the present situation may be treated as if the women were all segregated in the department of liberal arts. When one pursues the matter behind the face of the commonly published statistics, he finds that the process of segregation extends much further than these indicate. So far has the process of differentiation gone that certain courses are essentially preempted by women, whereas in others the men reign solitary and supreme. There is, to be sure, no rigid uniformity among the various institutions as regards the particular courses which are thus apportioned. But the phenomena of segregation is practically universal, so that in many classes the spirit of coeducation is buried under the substance of a female seminary or a man's college, as the case may be. Thus it will be found that the classes in English literature have been largely appropriated by women. History, the modern languages and classical studies show in many institutions a large invasion of women, while mathematics, geology and biology, together with the philosophical and social sciences, furnish a transition to the exact sciences and to studies of an advanced character immediately preparatory for law, medicine and technology, in which the men have things almost to themselves. The distribution

culiarities of organization in a few institutions must also be taken into account. Northwestern University, for example, has a large conservatory of music, chiefly patronized by women. This is not taken into account in our figures, which are meant to render comparative statements as nearly as possible reliable and significant. The figures quoted are believed to be entirely trustworthy for this purpose.

of the women as regards the relative numbers pursuing the several subjects offered by the curriculum, seem to be closely similar to that obtaining in the courses in women's colleges, so far as statistics are available and elective conditions comparable. It will be understood of course that these rough classifications refer solely to elective work taken in the broad sense, and not to such courses as are specifically prescribed for every academic degree.

One inevitably questions what this tendency means, what its final outcome is to be, and whether it is to be regarded as a welcome sign or not. It is clear, as regards the first point, that two influences are predominantly responsible for the general result. The first is found in the disposition to mold collegiate work from the earliest possible moment in such a manner as most effectively to assist in the preparation for a professional career. The second is found in the tendency to cultivate established tastes and to foster spontaneous intellectual interests.

The efficacy of the first consideration in the case of men is not open to doubt. In those parts of the country where collegiate coeducation is the prevailing system, the great mass of the young men are expecting immediately after graduation to enter upon a business or professional career, and this intention frequently leads them early in their college course to desert the humanities and the more purely cultural studies, so called, in favor of what they, or the faculties of the professional schools, consider the branches of immediately practical value. Literature and the classics rapidly surrender their claims upon these young men to economics, political science, constitutional history, physics, chemistry, biology, etc. In every large undergraduate body there is naturally always a considerable group of men who conceive of their educational opportunities in a more liberal manner than this, and another group cherishing more or less definite intention of graduate specialization in some of the departments of collegiate work other than those allied with the professional schools. Taken together these groups supply a considerable masculine leaven to what might otherwise in many of the courses in the humanities be a hopelessly feminine lump.

The women taken in mass are also widely controlled by professional considerations. However it may be in the colleges exclusively for women, there can be no reasonable question that up to the present time, at least, large numbers of the women in coeducational institutions have been looking forward to self-support. Or, at all events, if this were not an explicit purpose in their collegiate course, it was a very comforting possible consequence, exercising an indirect influence over their selection of studies. By common consent medicine and teaching are the two professions really open to women. Consequently the average college wo-

man who intends to live by her brains feels that she must choose between the two. The opportunities open to women in a business career have hitherto been too precarious or too purely clerical to attract extensive attention from college-bred women. It is not necessary to point out the reasons which lead the vast majority of college women, who are looking to self-support, to choose the profession of teaching, nor yet to dwell upon the further reasons which practically confine the larger number of them to work in the secondary schools, whose fate is already largely in their hands. Admitting the facts, we at once have a reason why large numbers of women elect the courses they do in college. It is the old familiar process of demand and supply. In no small measure, then, the educational phenomenon from which we started, *i. e.*, the segregation of the sexes in pursuit of different subjects, is attributable to social and economic causes.

Women will probably continue their plethoric patronage of the courses in literature and the humanities at coeducational institutions as long as the secondary schools offer them smaller salaries than are paid to properly trained men, and as long as other vocations requiring a college education are closed to them. It is possible that some relief may be found through the dawning of the halcyon days, so longed for by certain eminent educational reactionaries, when required curricula will supersede the elective system, and the humanities once more come to their own. The wandering male sheep would thus be brought back into the fold. Certainly the progressive suicide of the elective system now going on in many institutions under the influence of professional tendencies is most interesting and suggestive. Moreover, there are reasons for thinking that if the opportunities for women teachers of physics and chemistry were larger, and the collegiate courses in these subjects arranged with less of reference to ulterior professional interests of a technological character, the number of women in such courses would be materially increased. Tradition is in these matters of some consequence, and men have so long conducted this work in the high schools that a rapid change is in no case a probability. There are, of course, exceptions to the rule even now.

When one comes to speak of the influence of native abilities, native tastes and intellectual interests in the election of courses, the available data are altogether less tangible. The prevalent doctrines concerning the mental differences of men and women are matters of dogma readily susceptible of neither proof nor disproof. In polite letters, as in society, woman has long figured as the adorable parent of men, not of ideas; as the repository of delicate sentiment rather than of accurate knowledge and in general, as the residuary legatee of all those interests which men do not care to cultivate. The evidence adducible

in support of the correctness of this view is often proclaimed as conclusive; and ranged behind it is the authority of sundry notable physiologists, psychologists, sociologists and gentlemen of fashion. The contrary view in accordance with which women are allowed to possess ideas, some of them even original, is supported by evidence almost as intelligible and by partisans quite as eminent and quite as confident. The fact seems to be that it is extremely difficult to demonstrate how much of a woman's intellectual bent is due to the sexual bias of her mind, and how much to the influences which surround her from cradle to grave. It may be, for example, that literature is intrinsically feminine in its character, and that exact science is dominantly masculine. In the meantime it must certainly be granted that the conditions environing many girls are from childhood on such as tend to cultivate a mild but definite variety of sentimentalism. It has been suggested that some of the methods of studying literature current in these days tend also to sentimentalism, and so appeal to established habits of the feminine mind, while repelling the masculine temper. Courses dealing with the more emotional and esthetic forms of literary criticism and appreciation must necessarily be exposed to some danger from this source. Possibly a slight corrective and palliative for the excessive cultivation of such courses by women might be found in a larger emphasis upon more masculine points of view.

It seems improbable, however, that the relatively small number of men in the courses in belles-lettres in coeducational institutions is due in any considerable degree to this asserted fact regarding native masculine tastes, nor in any indisposition on the part of the men to sit in classes with women. For, as regards the second point, it must be remembered that there are many courses in which both men and women are well represented, and in which the ratio of the sexes to one another has changed but little throughout considerable periods. This is true, for example, of certain courses in history. The first point gains an interesting side light from the observation that in several important eastern institutions for men, where the modes of exposition and instruction in literature do not differ absolutely from those in vogue in western coeducational colleges, the attendance upon such courses shows in recent years no extreme shrinkage, and, as regards certain courses in English, even exhibits a marked development. The most obvious explanation of this difference between the east and the west (over and above the influence of the stimulating personality of certain successful instructors) is unquestionably to be found in the social conditions of which we have already spoken. The appreciation of the educational value of literature is necessarily more circumscribed in new and less wealthy communities than in those which have been

long established, and the pressure toward the obviously practical is inevitably far greater. The astonishing development of technological schools in western universities affords striking confirmation of this last named tendency—a tendency by the way which finds a counterpart in the rapid growth of the so-called scientific schools in great eastern universities.

The final explanation which some misogynists would offer for the predominance of women in English courses, *i. e.*, that English literature is ordinarily the easiest of college courses unhappily proves too much. Such statistics as are available tend to show that were this generally conceded, women would rarely preponderate in such classes. On the whole, therefore, it seems probable that although the taste for literature is more largely developed in the women of our coeducational colleges, while the taste for exact science is largely the property of the men, the factor which has produced the most extreme and anomalous conditions of sex segregation, is, especially as regards the men, professional, economic and social in character. Moreover, that which passes as native taste is itself often a mere expression of social and domestic pressure, emphasizing with relentless insistence certain interests as sexually appropriate or practically valuable.

Opinions are somewhat divergent touching the desirability of this educational situation. The instructors of the classes largely dedicated to women are sometimes a trifle violent in the expression of their views. The instructors of the men's sections are, on the other hand, generally complacent. The unbiased spectator is perplexed and baffled. Evidently the advantages and disadvantages of these extreme cases must be weighed in terms of the general educational effects of the system as indicated by its results throughout these institutions as a whole. It is necessary, therefore, to review briefly the current criticisms upon the system, most of which, be it said, are hallowed by age, and many of which are evidently trivial.

A warning hand must be held out at this point against the amiable and ubiquitous inconsequentialist who insists on confusing the problem of coeducation with the problem of the higher education of women. The two are indeed connected, but by no means identical. Collegiate coeducation as a system assumes as a premise that women are to receive collegiate education, if they so desire, and a study of the curricula of women's colleges indicates that women generally wish to pursue those branches offered in the colleges for men. The coeducational problem is not, however, fundamentally one of curricula. It is a problem of determining the conditions under which men and women shall study in any curriculum whatsoever.

The criticisms of the present day upon coeducation dealing in part

with strictly educational questions, and in part with general social considerations, differ in a somewhat suggestive manner as concerns one particular from those which were most commonly encountered in the early days of coeducation. The most frequent probably of all criticisms was the hygienic one. Although it was a matter of prehistoric knowledge that women could work all day in the field, many learned persons predicted a speedy decline for the audacious young female who attempted to follow the same collegiate course as her brother. The young person referred to has, however, both in coeducational colleges and in colleges for women, generally insisted on the retention of oppressively good health. And she has done even worse things to discredit the general calling of prophet by discovering numbers of educated men who were willing and eager to attempt matrimony with her assistance. Worst of all, when she has married, she has had a normal number of vigorous children. The irreconcilables on these points generally deny themselves the luxury of the available statistics. This is by no means to call in question the possibility held out to an injudicious girl of ruining her health by social and mental dissipation at a coeducational college. She can in this way undoubtedly emulate some of her sisters at women's colleges and certain of her brothers at men's universities.

But the intelligent contemporary opponent of coeducation has largely lost interest in the health of college women, and he has of late more often turned his attention to the baleful influence of the sex on social and intellectual standards. It is maintained, for instance, by an occasional instructor that women lower the level of scholarship in his classes. He finds it impossible to make such rigorous exactions of them as he would of men, and in consequence the whole tone of his class is contaminated. There seems reason to believe that this opinion is largely subjective in its basis, and it is suggestively rare on the lips of instructors educated in coeducational institutions. The instructor may have allowed himself to secure from his classes what he deemed the best work by the aid of a class room manner which he properly considers incompatible with the presence of ladies. In such cases one may fairly question the propriety of the pedagogical method. He may cherish a purely sentimental attitude toward women. This is a not infrequent circumstance in the case of young men brought up in men's colleges, and exposed for the first time to the ravages of coeducation. In this case time or matrimony or both are likely to cure his complaint. Certainly there are plenty of instructors who have taught in men's colleges without detecting any such decline of standard upon transferring the scene of their labors to coeducational institutions. Indeed, a contrary opinion has been not infrequently expressed, and one even hears the antithetical argument soberly advanced that women inevitably

outstrip the men in mere class room exercises, and that the latter should consequently be spared such depressing competition. A few eminent Harvard professors have even gone so far as to rank their students at Radcliffe higher than the men in the corresponding Harvard classes. This may of course be the exception which proves the rule. One may safely surmise that there are no wider differences in point of scholarship between coeducational institutions as a class and men's colleges, than there are among men's colleges themselves. Indeed, in elective courses, in which the men and women are represented in anything like equal numbers, a common verdict of instructors concerning their relative merits is that the women are on the average the better students. They seldom attain the eminence of the ablest men, but the ablest men are excessively rare. There is certainly no palpable proof and not even good circumstantial evidence to convict women of lowering the undergraduate standards of scholarship.

A subtler form of this same criticism aimed at American education in general, but especially applicable to coeducational institutions, is the assertion that women exercise a repressive influence upon the spirit of research for which they have as a sex neither capacity nor appreciation. Inasmuch as a real university must get its highest inspiration from the spirit of investigation it is obviously a matter of paramount importance to prevent women from securing any considerable influence in university life. This argument can be made rhetorically effective, but it begs the whole question and will carry no conviction to one not already convinced.

The disrespect for women's intellectual capacity, indicated in the above criticisms, sometimes takes still another form in the charge that as a class women are not serious-minded in their work. For many of them, it is said, life is a game with matrimony as its principal stake, and college work is but an amusing episode. Coupled with another frequent criticism based upon the professional tendencies of which we have already spoken, *i. e.*, that the intellectual horizon of college women is too often bounded by purely utilitarian considerations of the bread and butter world of pedagogics, this leaves women in possession of few academic virtues. Apparently they are either too strenuous or too flippant, and both characteristics are institutionally undesirable.

It must be remembered that coeducational colleges inconsiderately differ very widely from one another, and so render the task of the generalizer extremely hazardous. Unquestionably one could find institutions where the frivolous society girl is overmuch in evidence, whereas in others the uncomely drudge doth too much abound, and probably neither of these young persons is wholesome in excess. But it is needless to say that in every coeducational university of impor-

tance there is a group larger than either of these groups made up of young women who are neither hopelessly flippant nor distressingly utilitarian in their intellectual interests. Moreover, if the venue be changed from the mere fact of sex to the possession of such characteristics as have been described, it would require a buoyant and oblivious nature to deny the counterpart of just such persons in the male portion of any large undergraduate body. It is certainly a cheering thing to think that no considerable number of young men in our colleges for the male sex are ever guilty of frivolity in their attitude toward academic opportunities. But such thinking has no special connection with fact, and is of a speculative rather than of a scientific character. Nor are there lacking in men's colleges those who toil unprofitably and overmuch to the end of attaining some mundane prize not wholly superior to the school teacher's stipend. Even the women's colleges produce these types.

Coeducation is often charged with an insidious suppression of freedom of expression in the class room. *Academische Freiheit* is endangered, therefore, by other enemies than college presidents and boards of trustees. Some subjects are evidently ill qualified for discussion in mixed classes. But it may be doubted whether the restrictions emanating from this source have been unmixed evils. The meritricious and obscene jests of literature, which some eminent scholars in men's colleges delight to dwell upon, can perhaps be spared. Surely there is no serious reason to fear that the male youth of the land will fail to secure outside the class room all the really indispensable development on this side of his appreciation for humor. In the fields of biology, where embarrassments might be supposed most inevitable, the difficulties have by no means proved so serious as anticipated. Nevertheless it must be admitted without scruple that women cause some restraint upon freedom of speech as charged in the indictment.

Although we have had constantly in mind undergraduate conditions, a word may be dropped in passing as regards the criticisms upon graduate work. There is undoubtedly an almost universal willingness among even the most acrimonious critics of coeducation that the few women who desire it shall be allowed the best possible opportunities for graduate work. The only exceptions are found among the small but aggressive group of interesting pre-raphaelite dogmatists who would do away with all collegiate education for women. There are plenty of scholarly men who insist that women will never become investigators of any consequence, but who admit their capacities for assimilation and who feel that as there must under existing conditions be some women teachers in both schools and colleges, it is desirable that they should receive the most thorough possible discipline. Women must expect to

find themselves occasionally received on these terms, therefore, if they aspire to scholastic specialization in graduate schools. It will be remembered that the undergraduate courses constitute for many of those who plan to teach in the secondary schools the sole opportunity for specialization. For them the undergraduate curriculum affords essentially a professional training, and subserves exactly the same function as does the graduate school for those who are preparing for collegiate positions.

It behooves us to hurry on to a rehearsal of some of the more seditious social tendencies for which coeducation is held responsible. Foremost among these charges in point of fatuity—for some of them are not fatuous at all—is the asserted blight upon college spirit caused by coeducation. Now college spirit is a capricious plant which blooms profusely in the light of athletic victories and often leads a sickly life of hibernation at other periods. As commonly set forth, it consists in the belief that one's own college is the best on earth, which in some particulars is to an intelligent person always patently untrue, and at times of overwhelming athletic defeat, a thing extremely difficult for even a partisan to formulate with vivacity. Conceived more seriously, it consists in respect and affection for one's alma mater, and in earnest devotion to her welfare. It is unquestionably assisted by the accumulation of institutional legend and tradition. These things come slowly and with age. It is helped into a condition of self-consciousness by all vital student organizations which do not forget their dependence upon the college. Secret societies in many colleges are certainly injurious to college spirit, not because they work consciously against it, but because they absorb wholly into themselves sentimental interests which should include the institution, and because too often they stir up vicious animosities among themselves in a manner which necessarily detracts from the solidarity of interests in the student body at large. The elective system, with its disintegration of classes, has, wherever it has gained an extensive foothold, apparently modified almost to the point of extinction the old-time forms of college spirit. These considerations affect coeducational colleges neither more nor less than other colleges. On the more serious side of respect and affection for one's college, it is certainly difficult to see why coeducation should be disastrous to college spirit in the case of students to whom the system had always seemed the natural thing, unless it can be shown, as it certainly can not, that all coeducational institutions are intrinsically inferior to institutions for the separate sexes. Sufficient insistence upon the shame and ignominy of sitting in classes with the weaker vessels may undoubtedly undermine respect for his college in the mind of a lad brought up in a preparatory school for boys. Other lads could un-

doubtedly be occasionally influenced in this way. No boy likes to be called effeminate, whether the charge be true or false. In these interesting methods of undermining college spirit, many enthusiastic persons are now engaged. The feeling which they are attempting to arouse and play upon rarely or never occurs spontaneously to a boy brought up in coeducational schools. It is only as one finds a constituency reared in non-coeducational schools that any extensive and sincere antipathy of this sort can be counted upon. Specific instances illustrative of this fact would be easy to mention. Elsewhere the animosity of the men toward the women, if it exists at all, is an evident pose so transparent and unreliable as to deceive no one. In some institutions it has gained a specious prominence through resentment that the women support male student organizations and interests so feebly. Depleted athletic treasuries have been active ferments in this form of anti-woman agitation. Meantime, if one wishes college spirit in its more demonstrative and vocal forms, he must, in young colleges, at least, arrange for athletic victories, and women have not proved a serious impediment to these.

A vaguer form of this same criticism is often met with in the charge that women exercise a deleterious effect on that impalpable something known as academic atmosphere. When this objection is run to ground it is generally found to refer to the depreciation of scholarship already sufficiently mentioned, or to certain social complications of which we shall speak in a moment, or to the fact that the spirit of an institution differs in some other important but unnamable particular from that peculiar to Oxford or Yale or Harvard. Needless to say, the last form of this criticism is quite beyond controversy. It only remains to point out that all attempts to imbue with this spirit the occasional men's colleges found in the coeducational region have failed, in the judgment of competent observers, quite as completely to secure this desired result as have the efforts in coeducational institutions. The difficulties involved are referable much more certainly to the absence of tradition due to the youth of these colleges and to geographically determined social conditions, than to coeducation. Moreover, it is questionable if these difficulties will ever be wholly removed, and still more questionable whether this would be desirable even if it were possible.

The asserted violation of reasonable social proprieties constitutes one of the most frequent and important sources of annoyance to the advocates of coeducation. To behold the campus dotted with couples, billing and cooing their way to an A.B., is a thing, it is said, to rejoice Venus or Pan rather than Minerva, and were it the frequent or necessary outcome of coeducation, the future of the system would certainly

be in jeopardy. No university can safely become a matrimonial bureau, nor yet a clearing house for flirtations. With the entire absence of supervision, which characterizes the attitude of many coeducational institutions toward the social life of students, it is not to be wondered at that an occasional silly boy and an occasional silly girl should occasionally do some extremely silly thing. It only remains to remember that the same boy and girl will, with remarkably few exceptions, do equally silly things whatever educational surroundings may be given them. Furthermore, institutions which have attempted to control these matters by fixed rules of deportment seem on the whole to have succeeded in producing rather more risqué escapades than those which eschew restrictions altogether. Public opinion has generally proved a safe guide in this direction. It would be folly to pretend that no social transgressions have occurred, but on the whole judged by any standard reasonably applicable to the situation, the relations of the men and women in the majority of such colleges seem to have been wholesome and unobjectionable. Instances of actual immorality have been so extremely rare as fairly to be considered pathological. That the future has some very serious perplexities in store on this score, however, for some peculiarly situated institutions of which we shall speak presently, seems more than probable. A very little injudicious conduct of the character under consideration goes far to create an atmosphere of a very obnoxious kind, and it is such infrequent but pervasive cases which cause anxiety to the friends and give courage to the foes of coeducation.

Even though actual flirtation is avoided, many critics insist that boys' interests are stimulated in other boys' sisters at a time when it would be quite as well if they could be diverted into entirely different channels, even football. Girls, it is said, are unduly excited by masculine attention at a critical time in their physiological development, when they might better be engaged in storing their minds with useful learning. On the other side of this account it is to be observed that the shock of the class room goes far to shatter the traditional masculine idol in the feminine mind. This destructive process is in the case of most young women in such coeducational colleges begun in the primary schools and carried without interruption up to the academic level. By means of this anti-romantic treatment girls are unquestionably spared much painful disillusionizing, and they are brought through a difficult period with probably a minimum of silliness and mawkish sentimentality. Moreover, they are often spared certain highly morbid experiences familiar to the authorities of girls' colleges. In the case of the boy there is abundant evidence to warrant the opinion that the grosser forms of vice to which he falls an occasional prey are rendered distinctly less alluring by daily contact with women

of refinement and intelligence. That he ordinarily becomes effeminized by such contact is a fantastic theory of some critics which finds absolutely no tangible evidence upon which to rest. Certainly his manners leave much to be desired at times on the side of polite usage and suggest very remotely the adoption of feminine habits, and judged by athletic prowess, which is under the circumstances a very ambiguous index, the facts tell quite another story. At all events, athletic teams of western coeducational colleges have not infrequently defeated the representatives of eastern colleges for men, *e. g.*, Yale, Princeton, Harvard, Brown, etc.

The complementary criticism that women necessarily suffer a loss of refinement and feminine nicety seems equally difficult of proof. It is certainly hard to point out any unavoidable features of coeducation which should inevitably preclude the development or retention of good manners and fine feeling. If the psychologists are correct, the acquirement of what we call manners belongs largely to a period antedating college life, and although a coarsening of the moral and esthetic fiber during this period would unquestionably appear in less refined conduct, it is not obvious that any such change commonly occurs, much less must occur under coeducational conditions. The fact seems rather to be that the college must inevitably expect to reflect in large measure the manners with which its students come already supplied, and these which are often admirable will be determined by the social standards prevailing in the families and communities from which they come. To be sure, the conditions of collegiate life afford an opportunity for throwing into vivid relief acquired social habits. They further afford admirable facilities for the discouragement of extreme variations from the accepted norm. But it is altogether problematic whether they can radically alter the level of the mass, at least this is doubtful under the prevalent conditions in most coeducational institutions where little or no supervision is exercised over students outside the class room. That the general tendency in all such colleges is toward a greater nicety of appreciation for social cultivation, can hardly be questioned. But the process of social leveling up is a slow one. There are no courses in the conventionalities, and no one should confuse the merits of such an institution with those of the young ladies' finishing schools of a great metropolis.

Much was said a few years ago of the certainty that the immediate future in university education belonged to the great urban institutions. It certainly seems probable that some of the most difficult problems in the near future belong to such of these institutions as are coeducational. If there is any serious menace contained in a predominance of the number of women over men in a college, these urban

institutions are especially exposed to it. The number of girls in any city of 500,000 people who possess means and leisure sufficient to permit attendance upon a college is very large. If the college opens its doors directly in the faces of these young women, it can arouse no astonishment that many of them should seek in. Moreover, in the western cities which enjoy a practical monopoly of the coeducational system among city institutions, the brothers of these young women will not regularly come with them, or indeed go to any college. They are many of them drafted into the ranks of business life, and the natural balance of the sexes, which is displayed in the lower grades of the coeducational public school, is here entirely to seek. The families which will chiefly serve as recruiting grounds for these young women will be those in which wealth or comfortable means have been acquired in the present generation. In families where college traditions go back a generation or two, both boys and girls, if they go to college at all, will go to institutions determined as a rule by other than merely geographical considerations. But the stronger the local college, the more will it invade the ranks of this latter class, and it will probably draw upon the girls more largely than upon the boys, because of the indisposition to allow girls to leave home and because of the lesser significance for them of collegiate family tradition.

It will be strange if among these city-bred girls of leisure, many of whom will enjoy ample means, there should not be found a goodly number who go to college inspired with the same noble sentiment that now animates a considerable number of young men preparing for college—the disposition to have a good time and do the correct thing. Young women of this variety have already found their way into a number of the coeducational institutions, even those located outside the cities, and their coming even in small numbers has been attended by a distinct change in certain features of the college atmosphere. Judged by its external and most palpable fruits, the condition thus produced suggests at times its counterpart as already recognized in men's colleges—undue leisure unwisely spent, injudicious amusements and too many of them. Seen from the inside, it more often means on its positive side, an ingenuous interest in the more distinctly social phases of college life, and on its negative side, a freedom from the more imperious and sordid cares of the impecunious. We are assured on high authority that in at least one of the great universities for men, the idle and unprofitable class of rich boys has been awakened to a sense of responsibility and opportunity which is bringing splendid returns to the life of the institution. This is a comforting doctrine, and if confirmed in the progress of time, it furnishes ample ground for a confident optimism in the solution by the women themselves of any

difficulties which may develop in coeducational institutions from these or similar sources. In any event women have in the century just past shown a disposition to lead, rather than to follow, in the furtherance of social reforms. Meantime it is clear that the urban coeducational university is exposed in larger degree than its rural neighbor to the perplexities mentioned.

It becomes increasingly evident as one surveys the situation that the antagonistic views of coeducation which are at present so conspicuous do not rest upon any radical disagreement as to the facts in the case, but depend almost solely upon the educational ideals and the social creeds which are applied in interpreting the facts. Much of the current discussion of the system is rendered futile by the obliviousness of the protagonists to this obvious consideration. If the life and spirit of Oxford or of Yale or of Harvard constitute one's sole standard of educational excellence, then the average coeducational institution will indeed seem a desolate waste. If one's ideal of social salvation for young women involves matrimony as its only god, and the chaperone as his prophet, then the coeducational regime must generally be condemned as a pagan system marking a barbarian stage of culture. Needless to say, such standards exist tacitly or explicitly in the minds of many cultured men and women who sincerely believe coeducation to be a vulgarizing retrograde influence in both social and intellectual life. It is ridiculous to pretend that the coeducational university can meet satisfactorily the demands laid upon it by such standards. This is not tantamount to admitting that the best coeducational institutions can not cope successfully at any point with Oxonian excellencies, much less is it equivalent to denying the possibility of developing refined and noble men and women under coeducational surroundings. But it is an admission of—nay an insistence upon—the fact that the only standards by which coeducation can pretend to be justified and by which it can be justly judged, are those intrinsic to the social and economic conditions which have produced it, and of which it is an integral part.

One may feel toward these conditions contempt, distrust, hatred—what one will—but one must take them into account if he will pass intelligent judgment upon coeducation. One may deplore the fact sincerely, as every lover of established order does, but he can not gainsay that the development of American social and economic life is rapidly carrying increasing numbers of women out of the beaten path of the domestic treadmill with its everlasting insistence upon the incident of sex into fields where social service is gauged by other standards than those of child-bearing, house-keeping and adorning pink teas. Efficiency is certain to be the touchstone by which women are tried

in these new fields, and they will go or stay in proportion as they do better or less well than men. The picture which one learned professor has recently drawn of an uprising of men to force by violence a return of women to their proper sphere, is the product of an inflamed imagination attempting to portray an oriental Utopia. In reality men are chiefly responsible for the changes now going forward, but they are neither the doctrinaires of academic dignity nor yet the leaders of cotillons; they are the seekers after commercial, industrial and professional efficiency. So long as the economic situation remains what it is as regards the principles and motives that control in it, no amount of merely hysterical criticism and opposition is likely seriously to modify the case. And so long, therefore, as many women prefer self-support to marriage on the terms they find the latter offered to them, women will remain primary items in the economic situation, and they cannot be treated in this realm from the merely sexual point of view.

Coeducation is a reflection, often unconscious, of the tendencies which have produced this condition. It represents historically, as well as intrinsically, the democratic disposition to offer equal educational opportunities so far as possible to every human being. The touchstone by which it tests worthiness for such opportunities is social service. So long as women show themselves worthy by this standard to receive the highest forms of education, they will be given opportunity to obtain it, and moreover they will probably, in western institutions at least, obtain it under coeducational auspices. Justly or unjustly the western mind is suspicious of a fallacy lurking in the proclaimed equality of instruction in women's colleges and annexes, with that given in men's colleges. Then, too, if there were no other considerations, the economic waste involved in supporting separate institutions for men and women would tell heavily in favor of coeducation in many western communities. 'Equal but different' is not in educational matters a generally palatable doctrine away from the Atlantic seaboard. If the male is intellectually an altogether superior individual, the female ought on democratic principles to be given a chance for improvement by contact with him.

As a matter of fact coeducation is one of the most characteristic expressions of the social evolution of modern and especially western life. It is not now, and is not likely soon to become, an adequate or satisfactory expression of social and educational ideals in old communities or at all events in the conservative strata of such communities, inheriting as these do directly and easily the traditions of the past, and consequently clinging tenaciously to custom. The few instances in which the system has made its way into New England institutions of collegiate rank are essentially sporadic and serve rather than other-

wise to emphasize the truth of this assertion. This fact is still further brought out by the observation that the hostility to the system is greatest in those institutions which are most intimately in contact with older ideals. If one follows the history of the development of the system, one is impressed with the fact that in its inception anyhow the movement possessed the true spirit of robust frontier democracy. It originated in the democratic impulse to give women the highest educational opportunities and to test their fitness for such opportunities by the use made of them, and not by *à priori* notions of the sexually appropriate. Its typical virtues are earnestness, honesty and vigor. It is frequently crude, but it is rarely shallow. It is often obtuse, but it is seldom perverse. It springs from a deep-seated social conviction that men and women are in the first instance human beings, and only secondarily devices for continuing the race. It involves in practice, whatever the theory, a vital scepticism concerning the sexuality of intellect, a position which finds interesting though generally unintentional confirmation in the curricula of women's colleges and annexes. Even under the guidance of learned men and women, it does not seem to have proven possible to better materially the curricula of the men's colleges, to which even the extremest variants are now approximated. Individual preference operating under a liberal elective system has almost everywhere displaced curricula developed under preconceived notions of the sexually fit. Upon the catholic range of these feminine preferences, we have already commented.

Coeducation assumes that if, as is apparently the case, men and women are to be thrown into increasingly intimate contact in relations that do not involve reference to sex, it is desirable that the formal educational process, so often falsely severed from the rest of life, should recognize this fact by bringing boys and girls into contact with one another all their lives.

Like all other influences making for the higher education of women, coeducation is necessarily opposed to the view that woman's only function is maternity, and that her only proper attainments are either of a domestic or sexual character. The condition of women in continental and oriental countries in which this view of woman has prevailed, and the social consequences which have sprung from it, leave no question in the western mind as to the preferable extreme, if one must have an extreme in this matter. On the other hand, the advocates of coeducation regard maternity as a function for which no education is too high nor too broad.

When one brings to bear upon coeducation standards that can fairly be considered intrinsic to it, one can but admit that in the past anyhow its operation has been remarkably successful. The register of

graduates from coeducational institutions shows that as a class the young men and women trained under these auspices are filling with honor the functions of the various stations to which life has called them. The beauty and sanctity of domestic life does not appear to have been shattered nor indeed shaken. In public station, to which large numbers of them have been summoned, they appear to have acquitted themselves with eminent credit. There is no great interest of any kind throughout the west in which men and women of this type will not be found important factors. This result may of course be in spite of their education, rather than because of it, and a different form of education might have produced better results. Admitting this, however, it remains to point out the fact, that in any event for the vast majority of these persons coeducation has not resulted in the disastrous fashion which it ought, if its critics were wholly correct. It must in this connection be remembered that there are many thousands of these graduates of coeducational colleges, so that the volume of contamination which disturbs the critics should be considerable and not difficult of recognition.

Coeducation has a monopoly of neither the virtues nor the vices of the educational world. It is a safe assertion that many young men and women would be better off in colleges of some other variety. Experience certainly suggests that a coeducational university is a dangerous place to send certain young men and especially certain young women, brought up in schools for boys or girls severally. The sending of certain girls to such coeducational institutions without providing for guardianship of any kind is often in the highest degree reprehensible. But for the average young person brought up in coeducational nurseries and secondary schools the university of this type is capable of supplying a peculiarly valuable training, and one which could be discarded only at great cost. The system represents so much that is intrinsic to the noblest and best spirit of democracy in the commonwealths where it flourishes, that its immediate overthrow would be hardly feasible even were it thought desirable. The state institutions, which furnish much the larger part of the coeducational constituency, could probably take no extreme measures without legislative endorsement, and this would certainly be very slow in coming. Private institutions are less hampered, and we may look to them for experimental research. Leland Stanford in the west has already discovered that while 500 women in an institution are tolerable and even valuable, 501 are not to be endured. Wesleyan University in the East has also seen a light, but one of a different hue from that seen at Stanford. At Wesleyan twenty per cent. of the student body may be women, but educational propriety draws the line at this point.

Turning to the present and the future, and applying standards properly applicable to the coeducational system, it must be admitted that on the instructional side only one difficulty of serious import appears to exist. This is the tendency toward sex segregation in certain courses of which we have already spoken at length. The most unequivocal advantages of coeducation spring from the fact of joint instruction, and any influences which tend to preclude this are unfortunate. For the various other alleged shortcomings of the system on this side, there is no conclusive evidence and opinion is hopelessly diverse. Furthermore, the criticisms which are advanced, so far as they are capable of satisfactory proof, concern the merely incidental and obviously remediable excrescences of the system, and not its fundamental principles. On the other hand there is almost complete unanimity of opinion regarding the difficulties actual and possible on the social side of coeducational college life.

This fact itself is altogether significant—essential unanimity of opinion regarding one class of difficulties, with radical and complicated differences regarding the other class.

It does not seem chimerical to hope that the first difficulty may at an early date in large measure take care of itself without artificial assistance. Despite the common assertion of the educational rhapsodists that women's native tastes are all in emotional and esthetic lines, even her religious bent included, a study of the elections made by women in the courses of both coeducational and women's colleges suggests, as we have already seen, a much more equitable and catholic distribution of her interests. As wider academic and professional fields open to women, and as the number of women increase who are not obliged to conform their collegiate work to immediate bread and butter interests, there will certainly be a less proportion of them found in the literary courses than at present. And on the other hand, as regards the men, there seems some reason to believe that we may see a reaction from the present extreme tendency to cater to a purely technical preparation for professional life. Certainly it is hard to believe that in the long run the racial confidence in the value of the humanities, shown by educational history, should not secure wider recognition than it often does at present from some of the builders of required curricula for the professions. It seems not improbable, too, that the reconstruction of the work of professional preparation both in school and college with its tendency toward a shortening of the collegiate course, will be accompanied by a disposition to include more of literature in the early part of the training than is now the case. And, as in the case of women just mentioned, there will unquestionably be an increasing number of men in coeducational institutions whose means will per-

mit, and whose tastes will dictate, a less hasty and slavish subserviency to the demands of professional training, and a longer dalliance with arts and letters. This disposition will be rapidly augmented by a wider appreciation of the educational value of these subjects on the part of the communities whence these young men come. Should these various influences cooperate, there can be no question that the present anomalous conditions would be extensively modified. At all events it would set the tide of men back into the humanities. It seems improbable that women will find it tempting or profitable in the near future to attempt extensively entrance upon law or technology or theology. But many of the courses involved in preparation for these careers will undoubtedly appeal to them in increasing measure.

Far and away the most serious problem which coeducation has to face is unquestionably that involved in maintaining proper social relations between the sexes, and this must, if solved permanently, gain its solution from the action of public sentiment in the student body itself. Faculty counsel and administrative suasion will do much, but in the last analysis the suppression of unprofitable and excessive social intercourse on the one hand, and the elimination of irrational sex prejudice on the other, must be accomplished through the force of sincere and enlightened student opinion. This is an altogether hopeful circumstance, although it points to a corrective which is necessarily slow in development and susceptible of temporary error. To distrust its final success is to repudiate the lesson of every liberalizing step which has resulted in making the American college student so completely his own master. Whether the method adopted will involve the social ostracism of women which exists in a mild form at several important coeducational universities, and in a pronounced form at one, it is difficult to say. Certainly the result at this last institution should commend itself to many opponents of the system, for it seems to have materially retarded the increase in the attendance of women such as has been experienced by other coeducational colleges. Evidently this method is calculated to correct only one form of excess in the relations of the sexes. Stupid prejudice is not likely to die under this treatment. Indeed, it will hardly die under any system, for there will probably always be men as there are now, both among faculty and students, who simply dislike personally to have women about. This feeling is moreover warmly reciprocated by some women. Such persons, if in coeducational institutions, should seize an early opportunity to transfer the scene of their labors. Nothing can be socially more unwholesome and more insidious in its effects upon personal dignity than life in a community where such forms of contempt and antisocial sentiment are general and sincere.

The deepest and truest ethical tendencies of the time emphasize not divisions of sex or creed or party, but the unity of social service. And this is social service not in the moralistic, goody-goody sense, but in the sense of actual social function. If men and women are to be fitted for life with this ideal in its broadest implication as a primary determinant of curriculum and method, then coeducation, judged either by its fruits or by its promise, and acknowledging frankly its defects, is unquestionably a hopeful system. When it shows itself clearly disastrous to the solidarity of the highest social interests, it will unquestionably be discarded. But it will not be discarded upon any purely doctrinaire considerations of sexual functions and capacities. Meantime each one of us in the last resort tests it all by his own social creed, and with most of us this is at bottom largely a matter of feeling and not a matter of carefully rationalized judgment, a reflection of our own training and surroundings and not a product of our purely logical processes. Complete agreement, therefore, upon the merits of coeducation is hardly to be looked for in the near future.

THE PRESENT POSITION OF CHEMICAL PHYSIOLOGY.*

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AN engineer who desires to thoroughly understand how a machine works must necessarily know its construction. If the machine becomes erratic in its action, and he wishes to put it into proper working order, a preliminary acquaintance with its normal structure and function is an obvious necessity.

If we apply this to the more delicate machinery of the animal body we at once see how a knowledge of function (physiology and pathology) is impossible without a preliminary acquaintance with structure or anatomy.

It is therefore not surprising, it is indeed in the nature of things, that physiology originated with the great anatomists of the past. It was not until Vesalius and Harvey by tedious dissections laid bare the broad facts of structure that any theorizing concerning the uses of the constituent organs of the body had any firm foundation.

Important and essential as the knowledge is that can be revealed by the scalpel, the introduction and use of the microscope furnished physiologists with a still more valuable instrument. By it much that was before unseen came into view, and microscopic anatomy and physiology grew in stature and knowledge simultaneously.

The weapons in the armory of the modern physiologist are multitudinous in number and complex in construction, and enable him in the experimental investigation of his subject to accurately measure and record the workings of the different parts of the machinery he has to study. But preeminent among these instruments stands the test-tube and the chemical operations typified by that simple piece of glass.

Herein one sees at once a striking distinction between the mechanism of a living animal and that of a machine like a steam engine or a watch. It is quite possible to be an excellent watchmaker or to drive a steam engine intelligently without any chemical knowledge of the various metals that enter into its composition. In order to set the mechanism right if it goes wrong all the preliminary knowledge which is necessary is of an anatomical nature. The parts of which an engine is composed are stable; the oil that lubricates it and the fuel that feeds

* Presidential address to the Physiological Section at the Belfast Meeting of the British Association for the Advancement of Science.

it never become integral parts of the machinery. But with the living engine all this is different. The parts of which it is made take up the nutriment or fuel and assimilate it, thus building up new living substance to replace that which is destroyed in the wear and tear associated with activity. This condition of unstable chemical equilibrium is usually designated metabolism, and metabolism is the great and essential attribute of a living as compared with a non-living thing.

It seems childish at the present day, and before such an audience as this, to point out how essential it is to know the chemical structure as well as the anatomical structure of the component parts of the body. But the early anatomists to whom I have alluded had no conception of the connection of the two sciences. Speaking of Vesalius, Sir Michael Foster says: "The great anatomist would no doubt have made use of his bitterest sarcasms had some one assured him that the fantastic school which was busy with occult secrets and had hopes of turning dross into gold would one day join hands in the investigation of the problems of life with the exact and clear anatomy so dear to him." Nor did Harvey, any more than Vesalius, pay heed to chemical learning. The scientific men of his time ignored and despised the beginning of that chemical knowledge which in later years was to become one of the foundations of physiology and the mainstay of the art of medicine.

The earliest to recognize this important connection was one whose name is usually associated more with charlatanry than with truth, namely, Paracelsus; and fifty years after the death of that remarkable and curious personality his doctrines were extended and developed by van Helmont. In spite, however, of van Helmont's remarkable insight into the processes of digestion and fermentation, his work was marred by the mysticism of the day which called in the aid of supernatural agencies to explain what could not otherwise be fully comprehended

In the two hundred and fifty years that have intervened between the death of van Helmont and the present day alchemy became a more and more exact science, and changed its name to chemistry, and a few striking names stand out of men who were able to take the new facts of chemistry and apply them to physiological uses. Of these one may mention Mayow, Lower, Boerhaave, Réaumur, Borelli, Spallanzani, and Lavoisier. Mulder and Holland and Liebig in Germany bring us almost to the present time, and I think they may be said to share the honor of being regarded as the father of modern chemical physiology. This branch of science was first placed on a firm basis by Wöhler when he showed that organic compounds can be built out of their elements in the laboratory, and his first successful experiments in connection with the comparatively simple substance urea have been followed by numberless others, which have made organic chemistry the vast subject it is to-day.

Sir Michael Foster's book on the History of Physiology, from which I have already quoted, treats of the older workers who laid the foundations of our science, and whose names I have not done much more than barely mention. Those interested in the giants of the past should consult it. But what I propose to take up this morning is the work of those who have during more recent days been engaged in the later stages of the building. The edifice is far from completion even now. It is one of the charms of physiological endeavor that as the older areas yield their secrets to the explorers new ones are opened out which require equally careful investigation.

If even a superficial survey of modern physiological literature is taken, one is at once struck with the great preponderance of papers and books which have a chemical bearing. In this the physiological journals of to-day contrast very markedly with those of thirty, twenty or even ten years ago. The sister science of chemical pathology is making similar rapid strides. In some universities the importance of biological chemistry is recognized by the foundation of chairs which deal with that subject alone; and though in the United Kingdom, owing mainly to lack of funds, this aspect of the advance of science is not very evident, there are signs that the date cannot be far distant when every well-equipped university or university college will follow the example set us at many seats of learning on the continent and at Liverpool.

With these introductory remarks let me now proceed to describe what appear to me to be the main features of chemical physiology at the present time.

The first point to which I shall direct your attention is the rapid way in which chemical physiology is becoming an exact science. Though it is less than twenty years since I began to teach physiology, I can remember perfectly well a time when those who devoted their work to the chemical side of the science might almost be counted on the fingers of one hand, and when chemists looked with scarcely veiled contempt on what was at that time called physiological chemistry: they stated that physiologists dealt with messes or impure materials, and therefore anything in the nature of correct knowledge was not possible. There was a good deal of truth in these statements, and if physiologists to-day cannot quite say that they have changed all that, they can at any rate assert with truth that they are changing it. This is due to a growing *rapprochement* between chemists and physiologists. Many of our younger physiologists now go through a thorough preliminary chemical training; and, on the other hand, there is a growing number of chemists—of whom Emil Fischer may be taken as a type—who are beginning to recognize the importance of a systematic study of substances of physiological interest. A very striking instance of this is seen in the progress of our knowledge of the carbohydrates, which has

culminated in the actual synthesis of several members of the sugar group. Another instance is seen in the accurate information we now possess of the constitution of uric acid. When Miescher began his work on the chemical composition of the nuclei of cells, and separated from them the material he called nuclein, he little foresaw the wide practical application of his work. We now know that it is in the metabolism of cell-nuclei that we have to look for the oxidative formation of uric acid and other substances of the purine family. Already the chemical relationships of uric acid and nuclein have taught practical physicians some of the secrets that underlie the occurrence of gout and allied disorders.

With the time at my disposal, it would be impossible to discuss all the chemico-vital problems which the physiologists of the present day are attempting to solve, but there is one subject at which many of them are laboring which seems to me to be of supreme importance —I mean the chemical constitution of proteid or albuminous substances. Proteids are produced only in the living laboratory of plants and animals; proteid metabolism is the main chemical attribute of a living thing; proteid matter is the all-important material present in protoplasm. But in spite of the overwhelming importance of the subject chemists and physiologists alike have far too long fought shy of attempting to unravel the constitution of the proteid molecule. This molecule is the most complex that is known: it always contains five, and often six, or even seven elements. The task of thoroughly understanding its composition is necessarily vast, and advance slow. But little by little the puzzle is being solved, and this final conquest of organic chemistry, when it does arrive, will furnish physiologists with new light on many of the dark places of physiological science.

The revival of the vitalistic conception in physiological work appears to me a retrograde step. To explain anything we are not fully able to understand in the light of physics and chemistry by labeling it as vital or something we can never hope to understand is a confession of ignorance, and, what is still more harmful, a bar to progress. It may be that there is a special force in living things that distinguishes them from the inorganic world. If this is so, the laws that regulate this force must be discovered and measured, and I have no doubt that those laws when discovered will be found to be as immutable and regular as the force of gravitation. I am, however, hopeful that the scientific workers of the future will discover that this so-called vital force is due to certain physical or chemical properties of living matter which have not yet been brought into line with the known chemical and physical laws that operate in the inorganic world, but which as our knowledge of chemistry and physics increases will ultimately be found to be subservient to such laws.

Let me take as an example the subject of osmosis. The laws which regulate this phenomenon through dead membranes are fairly well known and can be experimentally verified; but in the living body there is some other manifestation of force which operates in such a way as to neutralize the known force of osmosis. Is it necessary to suppose that this force is a new one? May it not rather be that our much vaunted knowledge of osmosis is not yet complete? It is quite easy to understand why a dead and a living membrane should behave differently in relation to substances that are passing through them. The molecules of the dead membrane are, comparatively speaking, passive and stable; the molecules in a membrane made of living cells are in a constant state of chemical integration and disintegration; they are the most unstable molecules we know. It is to be expected that such molecules would allow water, or substances dissolved in water, to pass between them and remain entirely inactive? The probability appears to me to be all the other way; the substances passing, or attempting to pass, between the molecules will be called upon to participate in the chemical activities of the molecules themselves, and in the building up and breaking down of the compounds so formed there will be a transformation of chemical energy and a liberation of what looks like a new force. Before a physicist decides that his knowledge of osmosis is final, let him attempt to make a membrane of some material which is in a state of unstable chemical equilibrium, a state in some way comparable to what is called metabolism in living protoplasm. I cannot conceive that such a task is insuperable, and when accomplished, and the behavior of such a membrane in an osmometer or dialyser is studied, I am convinced that we shall find that the laws of osmosis as formulated for such dead substances as we have hitherto used will be found to require revision.

Such an attitude in reference to vital problems appears to be infinitely preferable to that which too many adopt of passive content, saying the phenomenon is vital and there is an end of it.

When a scientific man says this or that vital phenomenon cannot be explained by the laws of chemistry and physics, and therefore must be regulated by laws of some other nature, he most unjustifiably assumes that the laws of chemistry and physics have all been discovered. He forgets, for instance, that such an important detail as the constitution of the proteid molecule has still to be made out.

The recent history of science gives an emphatic denial to such a supposition. All my listeners have within the last few years seen the discovery of the Röntgen rays and the modern development of wireless telegraphy. On the chemical side we have witnessed the discovery of new elements in the atmosphere and the introduction of an entirely new branch of chemistry called physical chemistry. With such examples

ready to our hands, who can say what further discoveries will not shortly be made, even in such well-worked fields as chemistry and physics?

The mention of physical chemistry brings me to what I may term the second head of my discourse, the second striking characteristic of modern chemical physiology: this is the increasing importance which physiologists recognize in a study of inorganic chemistry. The materials of which our bodies are composed are mainly organic compounds, among which the proteids stand out as preeminently important; but every one knows there are many substances of the mineral or inorganic kingdom present in addition. I need hardly mention the importance of water, of the oxygen of the air, and of salts like sodium chloride and calcium phosphate.

The new branch of inorganic chemistry called physical chemistry has given us entirely new ideas of the nature of solutions, and the fact that electrolytes in solution are broken up into their constituent ions is one of fundamental importance. One of the many physiological aspects of this subject is seen in a study of the action of mineral salts in solution on living organisms and parts of organisms. Many years ago Dr. Ringer showed that contractile tissues (heart, cilia, etc.) continue to manifest their activity in certain saline solutions. Howell goes so far as to say, and probably correctly say, that the cause of the rhythmical action of the heart is the presence of these inorganic substances in the blood or lymph which usually bathes it. The subject has more recently been taken up by Loeb and his colleagues at Chicago: they confirm Ringer's original statements, but interpret them now as ionic action. Contractile tissues will not contract in pure solutions of non-electrolytes like sugar or albumin. But different contractile tissues differ in the nature of the ions which are their most favorable stimuli. An optimum salt solution is one in which stimulating ions, like those of sodium, are mixed with a certain small amount of those which like calcium restrain activity. Loeb considers that the ions act because they affect either the physical condition of the colloidal substances (proteid, etc.) in protoplasm or the rapidity of chemical processes.

Amœboid movement, ciliary movement, the contraction of muscle, cell division and karyokinesis all fall into the same category as being mainly dependent on the stimulating action of ions.

Loeb has even gone so far as to consider that the process of fertilization is mainly ionic action; he denies that the nuclein of the male cell is essential, but asserts that all it does is to act as the stimulus in the due adjustment of the proportions of the surrounding ions, and supports this view by numerous experiments on ova in which without the presence of spermatozoa he has produced larvæ by merely altering the saline constituents and so the osmotic pressure of the fluid that sur-

rounds them. Whether such a sweeping and almost revolutionary notion will stand the test of further verification must be left to the future; so also must the equally important idea that nervous impulses are to be mainly explained on an electrolytic basis. But whether or not all the details of such work will stand the test of time, the experiments I have briefly alluded to are sufficient to show the importance of physical chemistry to the physiologist, and they also form a useful commentary on what I was saying just now about vitalism. Such eminently vital phenomena as movement and fertilization are to be explained in whole or in part as due to the physical action of inorganic substances. Are not such suggestions indications of the undesirability of postulating the existence of any special mystic vital force?

I have spoken up to this point of physical chemistry as a branch of inorganic chemistry; there are already indications of its importance also in relation to organic chemistry. Many eminent chemists consider that the future advance of organic chemistry will be on the new physical lines. It is impossible to forecast where this will lead us; suffice it to say that not only physiology, but also pathology, pharmacology, and even therapeutics, will receive new accessions to knowledge the importance of which will be enormous.

I have now briefly sketched what appear to me to be the two main features of the chemical physiology of to-day, and the two lines, organic and inorganic, along which I believe it will progress in the future.

Let me now press upon you the importance in physiology, as in all experimental sciences, of the necessity first of bold experimentation, and secondly of bold theorizing from experimental data. Without experiment all theorizing is futile; the discovery of gravitation would never have seen the light if laborious years of work had not convinced Newton that it could be deduced from his observations. The Darwinian theory was similarly based upon data and experiments which occupied the greater part of its author's lifetime to collect and perform. Pasteur in France and Virchow in Germany supply other instances of the same devotion to work which was followed by the promulgation of wide-sweeping generalizations.

And after all it is the general law which is the main object of research; isolated facts may be interesting and are often of value, but it is not until facts are correlated and the discoveries ascertain their interrelationships that anything of epoch-making importance is given to the world.

It is, however, frequently the case that a thinker with keen insight can see the general law even before the facts upon which it rests are fully worked out. Often such bold theorizers are right, but even if

they ultimately turn out to be wrong, or only partly right, they have given to their fellows some general idea on which to work; if the general idea is incorrect, it is important to prove it to be so in order to discover what is right later on. No one has ever seen an atom or a molecule, yet who can doubt that the atomic theory is the sheet anchor of chemistry? Mendeleeff formulated his periodic law before many of the elements were discovered; yet the accuracy of this great generalization has been such that it has actually led to the discovery of some of the missing elements.

I propose to illustrate these general remarks by a brief allusion to two typical sets of researches carried out during recent years in the region of chemical physiology. I do not pretend that either of them has the same overwhelming importance as the great discoveries I have alluded to, but I am inclined to think that one of them comes very near to that standard. The investigations in question are those of Ehrlich and of Pawlow. The work of Ehrlich mainly illustrates the useful part played by bold theorizing, the work of Pawlow that played by the introduction of new and bold methods of experiment.

I will take Pawlow first. This energetic and original Russian physiologist has by his new methods succeeded in throwing an entirely new light on the processes of digestion. Ingeniously devised surgical operations have enabled him to obtain the various digestive juices in a state of absolute purity and in large quantity. Their composition and their actions on the various foodstuffs have thus been ascertained in a manner never before accomplished; an apparently unfailing resourcefulness in devising and adapting experimental methods has enabled him and his fellow workers to discover the paths of the various nerve impulses by which secretion in the alimentary canal is regulated and controlled. The importance of the physical element in the process of digestion has been experimentally verified. If I were asked to point out what I considered to be the most important outcome of all this painstaking work, I should begin my answer by a number of negatives, and would say, not the discovery of the secretory nerves of the stomach or pancreas; not the correct analysis of the gastric juice, nor the fact that the intestinal juice has most useful digestive functions; all of these are discoveries of which any one might have been rightly proud; but after all they are more or less isolated facts. The main thing that Pawlow has shown is that digestion is not a succession of isolated acts, but each one is related to its predecessor and to that which follows it; the process of digestion is thus a continuous whole; for example, the acidity of the gastric juice provides for a delivery of pancreatic juice in proper quantity into the intestine; the intestinal juice acts upon the pancreatic, and so enables the latter to perform its powerful actions. I am afraid this example, as I have tersely stated it,

presents the subject rather inadequately, but it will serve to show what I mean. Further, the composition of the various juices is admirably adjusted to the needs of the organism; when there is much proteid to be digested, the proteolytic activity of the juices secreted is correspondingly high, and the same is true for the other constituents of the food. It is such general conclusions as these, the correlation of isolated facts leading to the formulation of the law that the digestive process is continuous in the sense I have indicated and adapted to the needs of the work to be done, that constitute the great value of the work from the Russian laboratory. Work of this sort is sure to stimulate others to fill in the gaps and complete the picture, and already has borne fruit in this direction. It has, for instance, in Starling's hands led to the discovery of a chemical stimulus to pancreatic secretion. This is formed in the intestine as the result of the action of the gastric acid, and taken by the blood-stream to the pancreas. Whether this *secretin* as it is called may be one of a group of similar chemical stimuli which operate in other parts of the body has still to be found out.

The other series of researches to which I referred are those of Ehrlich and his colleagues and followers on the subject of immunity. This subject is one of such importance to every one of us that I am inclined to place the discovery on a level with those great discoveries of natural laws to which I alluded at the outset of this portion of my address. I hesitate to do so yet because many of the details of the theory still await verification. But up to the present all is working in that direction, and Ehrlich's ideas illustrate the value of bold theorizing in the hands of clear-sighted and far-seeing individuals.

But when I say that the doctrine is bold, I do not mean to infer that the experimental facts are scanty; they are just the reverse. But in the same way that a chemist has never seen an atom, and yet he believes atoms exist, so no one has yet ever seen a toxin or antitoxin in a state of purity, and yet we know they exist, and this knowledge promises to be of incalculable benefit to suffering humanity.

It may not be uninteresting to state briefly, for the benefit of those to whom the subject is new, the main facts and an outline of the theory which is based upon them.

We are all aware that one attack of many infective maladies protects us against another attack of the same disease. The person is said to be *immune* either partially or completely against that disease. Vaccination produces in a patient an attack of cowpox or vaccinia. This disease is related to smallpox, and some still hold that it is smallpox modified and rendered less malignant by passing through the body of a calf. At any rate an attack of vaccinia renders a person immune to smallpox, or variola, for a certain number of years. Vaccination is an instance of what is called *protective inoculation,* which is now practised

with more or less success in reference to other diseases like plague and typhoid fever. The study of immunity has also rendered possible what may be called *curative inoculation,* or the injection of antitoxic material as a cure for diphtheria, tetanus, snake poisoning, etc.

The power the blood possesses of slaying bacteria was first discovered when the effort was made to grow various kinds of bacteria in it; it was looked upon as probable that blood would prove a suitable soil or medium for this purpose. It was found in some instances to have exactly the opposite effect. The chemical characters of the substances which kill the bacteria are not fully known; indeed, the same is true for most of the substances we have to speak of in this connection. Absence of knowledge on this particular point has not, however, prevented important discoveries from being made.

So far as is known at present, the substances in question are proteid in nature. The bactericidal powers of blood are destroyed by heating it for an hour to 56° C. Whether the substances are enzymes is a disputed point. So also is the question whether they are derived from the leucocytes; the balance of evidence appears to me to be in favor of this view in many cases at any rate, and phagocytosis becomes more intelligible if this view is accepted. The substances, whatever be their source or their chemical nature, are sometimes called alexins, but the more usual name now applied to them is that of *bacterio-lysins.*

Closely allied to the bactericidal power of blood, or blood-serum, is its globulicidal power. By this one means that the blood-serum of one animal has the power of dissolving the red blood-corpuscles of another species. If the serum of one animal is injected into the blood-stream of an animal of another species, the result is a destruction of its red corpuscles, which may be so excessive as to lead to the passing of the liberated hæmoglobin into the urine (hæmoglobinuria). The substance or substances in the serum that possess this property are called *hæmolysins,* and though there is some doubt whether bacterio-lysins and hæmo-lysins are absolutely identical, there is no doubt that they are closely related substances.

Another interesting chemical point in this connection is the fact that the bactericidal power of the blood is closely related to its alkalinity. Increase of alkalinity means increase of bactericidal power. Venous blood contains more diffusible alkali than arterial blood and is more bactericidal; dropsical effusions are more alkaline than normal lymph and kill bacteria more easily. In a condition like diabetes, when the blood is less alkaline than it should be, the susceptibility to infectious diseases is increased. Alkalinity is probably beneficial because it favors those oxidative processes in the cells of the body which are so essential for the maintenance of healthy life.

Normal blood possesses a certain amount of substances which are inimical to the life of our bacterial foes. But suppose a person gets run down; every one knows he is then liable to 'catch anything.' This coincides with a diminution in the bactericidal power of his blood. But even a perfectly healthy person has not an unlimited supply of bacterio-lysin, and if the bacteria are sufficiently numerous he will fall a victim to the disease they produce. Here, however, comes in the remarkable part of the defence. In this struggle he will produce more and more bacterio-lysin, and if he gets well it means that the bacteria are finally vanquished, and his blood remains rich in the particular bacterio-lysin he has produced, and so will render him immune to further attacks from that particular species of bacterium. Every bacterium seems to cause the development of a specific bacterio-lysin.

Immunity can more conveniently be produced gradually in animals, and this applies, not only to the bacteria, but also to the toxins they form. If, for instance, the bacilli which produce diphtheria are grown in a suitable medium, they produce the diphtheria poison, or toxin, much in the same way that yeast-cells will produce alcohol when grown in a solution of sugar. Diphtheria toxin is associated with a proteose, as is also the case with the poison of snake venom. If a certain small dose called a 'lethal dose' is injected into a guinea-pig the result is death. But if the guinea-pig receive a smaller dose it will recover; a few days after it will stand a rather larger dose; and this may be continued until after many successive gradually increasing doses it will finally stand an amount equal to many lethal doses without any ill effects. The gradual introduction of the toxin has called forth the production of an antitoxin. If this is done in the horse instead of the guinea-pig the production of antitoxin is still more marked, and the serum obtained from the blood of an immunized horse may be used for injecting into human beings suffering from diphtheria, and rapidly cures the disease. The two actions of the blood, antitoxic and antibacterial, are frequently associated, but may be entirely distinct.

The antitoxin is also a proteid probably of the nature of a globulin; at any rate it is a proteid of larger molecular weight than a proteose. This suggests a practical point. In the case of snake-bite the poison gets into the blood rapidly owing to the comparative ease with which it diffuses, and so it is quickly carried all over the body. In treatment with the antitoxin or antivenin, speed is everything if life is to be saved; injection of this material under the skin is not much good, for the diffusion into the blood is too slow. It should be injected straight away into a blood-vessel.

There is no doubt that in these cases the antitoxin neutralizes the toxin much in the same way that an acid neutralizes an alkali. If

the toxin and antitoxin are mixed in a test-tube, and time allowed for the interaction to occur, the result is an innocuous mixture. The toxin, however, is merely neutralized, not destroyed; for if the mixture in the test-tube is heated to 68° C. the antitoxin is coagulated and destroyed and the toxin remains as poisonous as ever.

Immunity is distinguished into *active* and *passive*. Active immunity is produced by the development of protective substances in the body; passive immunity by the injection of a protective serum. Of the two the former is the more permanent.

Ricin, the poisonous proteid of castor-oil seeds, and *abrin*, that of the Jequirity bean, also produce when gradually given to animals an immunity, due to the production of antiricin and antibrin respectively.

Ehrlich's hypothesis to explain such facts is usually spoken of as the *side-chain theory* of immunity. He considers that the toxins are capable of uniting with the protoplasm of living cells by possessing groups of atoms like those by which nutritive proteids are united to cells during normal assimilation. He terms these *haptophor* groups, and the groups to which these are attached in the cells he terms *receptor* groups. The introduction of a toxin stimulates an excessive production of receptors, which are finally thrown out into the circulation, and the free circulating receptors constitute the antitoxin. The comparison of the process to assimilation is justified by the fact that non-toxic substances like milk introduced gradually by successive doses into the blood-stream cause the formation of anti-substances capable of coagulating them.

Up to this point I have spoken only of the blood, but month by month workers are bringing forward evidence to show that other cells of the body may by similar measures be rendered capable of producing a corresponding protective mechanism.

One further development of the theory I must mention. At least two different substances are necessary to render a serum bactericidal or globulicidal. The bacterio-lysin or hæmolysin consists of these two substances. One of these is called the *immune body*, the other the *complement*. We may illustrate the use of these terms by an example. The repeated injection of the blood of an animal (*e. g.*, the goat) into the blood of another animal (*e. g.*, a sheep) after a time renders the latter animal immune to further injections, and at the same time causes the production of a serum which dissolves readily the red blood-corpuscles of the first animal. The sheep's serum is thus hæmolytic towards goat's blood-corpuscles. This power is destroyed by heating to 56° C. for half an hour, but returns when fresh goat's serum is added. The specific immunizing substance formed in the sheep is called the immune body; the ferment-like substance destroyed by heat

is the complement. The latter is not specific, since it is furnished by the blood of non-immunized animals, but it is nevertheless essential for hæmolysis. Ehrlich believes that the immune body has two side groups—one which connects with the receptor of the red corpuscles and one which unites with the haptophor group of the complement, and thus renders possible the ferment-like action of the complement on the red corpuscles. Various antibacterial serums which have not been the success in treating disease they were expected to be are probably too poor in complement, though they may contain plenty of the immune body.

Quite distinct from the bactericidal, globulicidal, and antitoxic properties of blood is its agglutinating action. This is another result of infection with many kinds of bacteria or their toxins. The blood acquires the property of rendering immobile and clumping together the specific bacteria used in the infection. The test applied to the blood in cases of typhoid fever, and generally called Widal's reaction, depends on this fact.

The substances that produce this effect are called *agglutinins*. They also are probably proteid-like in nature, but are more resistant to heat than the lysins. Prolonged heating to over 60° C. is necessary to destroy their activity.

Lastly, we come to a question which more directly appeals to the physiologist than the preceding, because experiments in relation to immunity have furnished us with what has hitherto been lacking, a means of distinguishing human blood from the blood of other animals.

The discovery was made by Tchistovitch (1899), and his original experiment was as follows: Rabbits, dogs, goats, and guinea-pigs were inoculated with eel-serum, which is toxic: he thereby obtained from these animals an antitoxic serum. But the serum was not only antitoxic, but produced a precipitate when added to eel-serum, but not when added to the serum of any other animal. In other words, not only has a specific antitoxin been produced, but also a specific *precipitin*. Numerous observers have since found that this is a general rule throughout the animal kingdom, including man. If, for instance, a rabbit is treated with human blood, the serum ultimately obtained from the rabbit contains a specific precipitin for human blood; that is to say, a precipitate is formed on adding such a rabbit's serum to human blood, but not when added to the blood of any other animal.* The great value of the test is its delicacy: it will detect the specific blood when it is greatly diluted, after it has been dried for weeks, or even when it is mixed with the blood of other animals.

* There may be slight reaction with the blood of allied animals; for instance, with monkey's blood in the case of man.

I have entered into this subject at some length because it so admirably illustrates the kind of research which is now in progress; it is also of interest to others than mere physiologists. I have not by any means exhausted the subject, but for fear I may exhaust my audience let me hasten to a conclusion. I began by eulogizing the progress of the branch of science on which I have elected to speak to you. Let me conclude with a word of warning on the danger of over-specialization. The ultra-specialist is apt to become narrow, to confine himself so closely to his own groove that he forgets to notice what is occurring in the parallel and intercrossing grooves of others. But those who devote themselves to the chemical side of physiology run but little danger of this evil. The subject cannot be studied apart from other branches of physiology, so closely are both branches and roots intertwined. As an illustration of this may I be permitted to speak of some of my own work? During the past few years the energies of my laboratory have been devoted to investigations on the chemical side of nervous activity, and I have had the advantage of cooperating to this end with a number of investigators, of whom I may particularly mention Dr. Mott and Dr. T. G. Brodie. But we soon found that any narrow investigation of the chemical properties of nervous matter and the changes this undergoes during life and after death was impossible. Our work extended in a pathological direction so as to investigate the matter in the brains of those suffering from nervous disease; it extended in a histological direction so as to determine the chemical meaning of various staining reactions presented by normal and abnormal structures in the brain and spinal cord; it extended in an experimental direction in the elucidation of the phenomena of fatigue, and to ascertain whether there was any difference in medullated and non-medullated nerve fibers in this respect; it extended into what one may call a pharmacological direction in the investigation of the action of the poisonous products of the breakdown of nervous tissues. I think I have said enough to show you how intimate are the connections of the chemical with the other aspects of physiology, and although I have given you but one instance, that which is freshest to my mind, the same could be said for almost any other well-planned piece of research work of a bio-chemical nature.

SCIENTIFIC PALMISTRY.

By Professor HARRIS HAWTHORNE WILDER, Ph.D.,
SMITH COLLEGE.

RISING from the waters of Kejemkoojic Lake in Nova Scotia there stands a series of smooth slaty rocks which appear to one approaching in a canoe so tempting a surface for the scratching of inscriptions that they are completely covered, as far up as one can read, with pictures, names, dates and meaningless scrawls, superimposed upon one another and successively the work of the aboriginal Micmac Indians, the French and the English. The oldest of these are undoubtedly pre-columbian, while at the present day additions are continually being made by vandalistic excursionists.

In spite of the superposition of these varied scrawls, Col. Garrick Mallory, who has made them the subject of special study, was able to separate the genuine Micmac inscriptions from the others and has published many of these in the United States Reports of the Bureau of American Ethnology. Among those he found the accompanying figure of the palmar surface of a human hand (Fig. 1)* which shows a remarkable degree of detail and must have been the result of an unusually careful observation. The figure will be better appreciated, perhaps, if the reader will first scrutinize the palmar surface of his own left hand in a strong light and compare it with his other hand and with the hands of two or three of his friends. It will be noticed, first, that the surface in question is marked by two distinct sets of markings; first, the wrinkles, which form the chief consideration of that means of amusement known as 'palmistry' and which are caused by the movements of the fingers and their muscles, and secondly the papillary ridges, which form the fundamental sculpture of the skin and run in approximately parallel directions across both the palm and the palmar surface of

Fig. 1. Indian Petroglyph from the Kejemkoojic Rocks, Nova Scotia, one half the size of the Original Drawing. After Mallory.

* Tenth Annual Report of the Bureau of Ethnology, p. 740, Fig. 1255.

the fingers, their general plan being unaffected by the presence of the wrinkles. By a more careful study of the papillary ridges it will be seen that they are often discontinued, reinforced by new ones, forked or, in a few cases, looped, and that in certain spots the usual course is interrupted by the insertion of a figure or 'pattern,' as it is technically called, in the form of a spiral, a whorl or a loop. Such patterns are of constant occurrence in the balls of the fingers, while the palm usually, though not always, possesses from one to four or five of them, located in certain definite localities, as at the base of the fingers or upon the raised, pad-like outer side of the palm, the hypothenar area. In rare cases such a pattern is met with upon the thenar area, at the base of the thumb (Fig. 6, *a*) but the fine parallel wrinkles almost always found in this region render it difficult to see.

It will be seen, now, by turning to the figure, that each of the above details has been indicated by the Micmac artist, not literally, as we should do it, but symbolically, that is, by something to suggest each detail. Thus in the drawing there are two sets of palmar lines; the foundation or background, consisting of fine lines approximately parallel, and evidently indicative of the papillary ridges, and the superimposed angular ones with little or no system, which represent the wrinkles. As for patterns, it is possible that the little curve near the outer margin may represent the hypothenar pattern, which, though not a constant element, is of frequent occurrence; and, at all events, the patterns at the finger tips are well indicated save in the case of the index finger where the omission is probably accidental. Here also the difference in the form of the separate patterns is well shown; that of the thumb is a spiral, a usual form for that digit, those of the third and fourth fingers are whorls and the curious cross or mark like the Arabic number four, found upon the little finger, may represent certain of the components of that form known as a loop.

Turning from Indian anatomy to Indian morphology, from the observation of facts to the construction of explanatory theories, we have the followng remarkable passage in one of the reports of the *Berliner Gesellschaft für Anthropologie* as cited by Col. Mallory, in connection with the figure of the hand and representing a conversation with one of the Bella Coola Indians of British Columbia.

The frequency with which partial representation of the eye are met with appeared to me so striking that I requested Mr. Jacobsen to ask the Bella Coola Indians whether they had any special idea in employing the eye so frequently. To my great surprise the person addressed pointed to the palmar surface of his finger tips and to the fine lineaments which the skin there presents; in his opinion a rounded or longitudinal field, such as appears between the converging or parallel lines, also means an eye, and the reason of this is that originally each part of the body terminated in an organ of sense, particu-

larly an eye, and was only afterward made to retrovert into such rudimentary conditions.*

This explanation is, of course, the merest guess-work, resulting from a fancied resemblance between an eye and the shape of a pattern, but by a singular chance, the theory comes nearer the truth than one would at first suspect, since these scrolls and loops, not only of the fingers, but those of the palm as well, are in reality rudiments, not of eyes, but of walking pads; a conclusion which, although it may seem at first a little fanciful, is reached by a simple course of reasoning and rests upon the comparison of easily available data, namely an inspection of the volar, or lower surfaces of the paws of various mammals.

The most typical, that is, the least modified mammalian paw is one with five toes and in which the entire volar surface, from the tips of the digits back to the wrist or heel, comes in contact with the ground during the act of walking. In such paws, as, for example, those found in most rodents and in many of the carnivora, it will be seen that the weight is borne by a series of ten projecting pads or permanent callosities, five of which are situated at the ends of the digits, while the remaining five are placed upon the surface of the palm or sole, and possess the definite arrangement shown in the accompanying diagram, (Fig. 2, *a*) namely, *one each for the thenar and hypothenar areas,* the raised portions associated respectively with the inner and outer margins, and *three placed in a transverse row at the bases of the four fingers and corresponding to the intervals between them.* In accordance with their positions, these pads may be conveniently named the *thenar,* the *hypothenar* and the *first, second* and *third palmar* (or *plantar,* in the case of the hind foot). Those at the ends of the digits may be designated as *apical* and numbered consecutively from *one* to *five.*

In actual cases, owing to the various modifications necessitated by habit and environment, such a diagrammatic arrangement is seldom completely realized, but often in an embryo, before the special modification characteristic of the adult form has been introduced, the condition closely approximates the typical one (Fig. 2, *b*). How these modifications may affect the original plan may be well seen by a comparison of the fore-paws of the mink and the common cat (Fig, 2, *c* and *d*), two carnivores representing different stages in the coalescence of the three palmar pads to form the characteristic cushion adapted for silent progression. In the mink these pads are still semi-distinct and the middle one exceeds the others in size, suggesting that, in the cat, this latter element forms the main bulk of the cushion, a conclusion proved to be the fact from the study of kitten embryos, as,

* *Verhandlungen der Berliner Gesellschaft für Anthropologie,* March 20, 1886, p. 208. (Translated by Col. Mallory.)

in successive stages of these the lateral pads appear at first distinct, then attached to the middle ones as a pair of lateral wings, and finally become completely fused. In the adult cushion the part furnished by each element is still traceable in the irregular contour of the resultant

FIG. 2a.

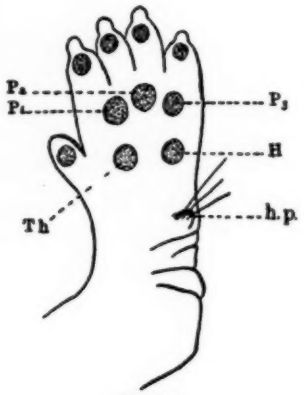


FIG. 2b.

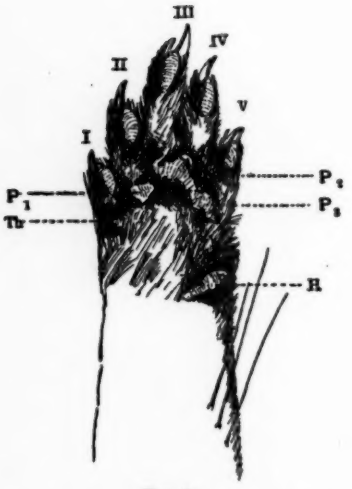


FIG. 2c.

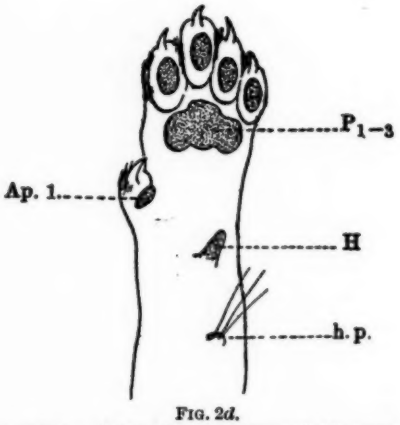


FIG. 2d.

FIG. 2. ARRANGEMENT OF PADS ON MAMMALIAN FOOT. (*a*) Typical arrangement; diagram. (*b*) Typical arrangement; forefoot of rat embryo. (*c*) Forefoot of mink, showing a slight modification of the type. (*d*) Forefoot of cat, showing fusion of palmar pads. Abbreviations: *A*, apical pads; P_1–P_3, palmar pads; *Th*, thenar pad; *H*, hypothenar pad; *h. p*, hair papilla; *I*–*V*, the digits.

mass. The noticeable projecting spur near the wrist is a modified hypothenar pad, but the small bristle-bearing papilla still farther up has nothing to do with it and is not a pad.

A singular modification of the type, and one which forms a necessary link in our present inquiry, is seen in monkeys, in which, owing to their arboreal life and the consequent substitution of climbing for walking, the pads have become low, flattened mounds, and the usual hard covering has softened to a soft epidermis marked with curiously disposed ridges, the seat of a highly developed tactile sense. The volar surface of the paws thus forms a delicate organ of touch, specially adapted to perceive the varying conditions of the tree-boughs, a power often of vital importance to the animal (Fig. 3). The epidermic or papillary ridges cover the entire volar surfaces and *designate the position of the typical pads by elaborate patterns in the forms of scrolls, loops and whorls* as may be seen by a comparison of the figures with the typical diagram. It will be noticed, however, that aside from the usual ten pads, there is seen a small accessory hypothenar, situated between the hypothenar and the third palmar, and that upon the fingers, aside from the apical patterns, there are suggestions of loops and other figures placed upon the first and second joints. The morphological significance of these extra parts is not known at present, and it is probable that they have not other meaning than an attempt to increase still farther the sensitiveness of the surface in places not covered by the original pads.

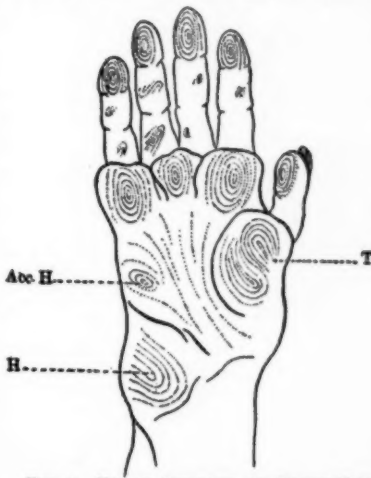


FIG. 3. VOLAR SURFACE OF RIGHT HAND OF LARGE MONKEY (*Inuus*): (from author's illustration in *Anat. Anzeiger*, 1896). *Acc. H*, Accessory hypothenar pad (other abbreviations as in Fig. 2).

To supply the next and final link in our chain of reasoning the reader may be asked to consult his own hand and compare it with Fig. 3. Upon this the apical pads, or patterns, as they may now be called, will be easily seen, much as in the Micmac drawings, and it is probable that one at least of the palmar patterns, and perhaps also the hypothenar, will be in evidence. Individual human hands differ greatly, however, in the patterns represented, the limits in the authors collection of one hundred palm-prints being shown in Fig. 4, both taken from whites of American parentage, yet differing from each other in the matter of patterns more than the first and more atavistic one differs from that of the monkey. In the same way Fig. 5 represents the extremes of a collection of about sixty sole-prints where the differences are as great as in the palms.

The great individual variation of these parts in the human being is not without significance and furnishes an excellent illustration of the biological truth *that the perfection and constancy of an organ are directly proportional to its necessity in the life of the organism.* Thus

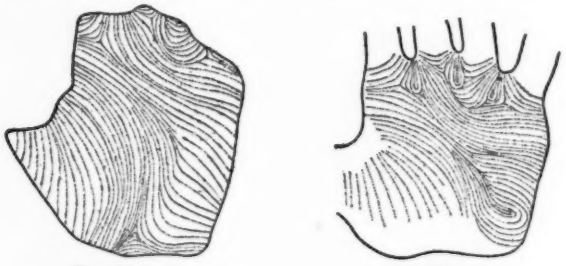


FIG. 4*a*. FIG. 4*b*.

FIG. 4. TRACINGS FROM PALM PRINTS, SHOWING RANGE OF VARIATION.

in an arboreal primate, an exact appreciation of the contact surfaces of the tree-boughs among which it climbs and swings is of vital importance, and the slightest defect or deviation from the standard in the organs furnishing that intelligence would be apt to prove fatal; but

FIG. 5*a*. FIG. 5*b*.

FIG. 5. TRACINGS FROM SOLE PRINTS, SHOWING RANGE OF VARIATION.

when such a being assumes a terrestrial life, so high a degree of sensitiveness in palms and soles is no longer necessary and the organ is allowed to lapse. Individual variations, no longer discouraged, tend to increase, and that which was once a necessary and vital arrangement

of the papillary ridges becomes of little importance. The influence of environment becomes entirely removed, and the only reason for the farther continuance of these parts is the conservative power of heredity, which may perpetuate, apparently for a vast period of time, characteristics no longer of necessity to the organism.

Briefly stated, the law described above is this: that only useful and important parts retain a certain normal form in the various individuals of a given species, and that, as they become of less importance, they tend more and more to vary individually, the range of variation increasing with time and the degree of uselessness, if such an expression may be allowed; conversely, an organ that is seen to possess marked individual variation is shown to be of secondary importance, and may be either a rudimentary organ, that is, one on the way towards a greater perfection in the future and in which the variations represent the numerous experiments or attempts to find the form best adapted for a special purpose, or, again, it may be a vestigial organ, or one in which its point of highest usefulness is passed and in which the variations represent various degrees of degeneracy, or stages in its gradual eradication from the organism.

Returning to the case under consideration, a brief mention should be made of another feature of the monkey palm or sole besides that of the patterns, and that is the low but evident mounds upon which the patterns are placed and which more properly represent the elevations or pads themselves. Although these have suffered more in the transition to the human form they are commonly not absent, even in the adult and may be seen with especial clearness in the embryo. In many adult hands the three palmar pads are clearly brought out by simply bending back the fingers and looking across the palmar region, and this notwithstanding the fact that the modern, rather ingenious 'science' of palmistry locates here four 'mounts' rather than three, and associates them with the fingers instead of with the intervals between them; an interesting illustration of what even the most careful observation will do without a rational basis.

The endless variety shown in the disposal of the epidermic ridges as outlined above will suggest several important lines of study, as, for example, the discovery of a system or of laws governing the variation; the possible influence of heredity upon the variation; and through this the possibility of the discovery of characters which may serve as criteria of race; the use of the markings in personal identification, and so on; and, although the simple scrutiny of a few palms may suffice for a preliminary examination, a need will soon be felt of some method by which a permanent and accurate record may be made, something in the form of a print or impression which may be available at all times

for purposes of study and comparison. Numerous methods of preparing such records have been elaborated at length by Mr. Francis Galton whose eminent labors upon the comparison and classification of the apical patterns have resulted in an elaborate and accurate system of personal identification, and for these the reader is referred to Chapter III. of his 'Finger Prints.'* The method found by the present author to be the most practicable is a slight modification of Galton's printing-ink method and may be best explained by a quotation from a set of direction prepared for the use of those willing to assist him in the collection of prints.

> The method of printing is a simple one, the only needful apparatus being (*a*) a tube of best quality black mimeograph ink, (*b*) a rubber roller six inches long, such as is sold with photographic outfits, and (c) white, unruled paper of a suitable size and quality. A large slate for spreading the ink is a useful accessory, but a smooth sheet of paper pasted upon a flat board or piece of cardboard will fulfil the requirements in this particular.
>
> In printing, a bit of ink should first be squeezed from the tube upon the slate or other surface used and should be spread evenly by rolling the rubber roller back and forth in various directions, until a thin layer of uniform thickness is spread over the flat surface. When the surface is in exactly the right state the palm or sole to be printed should first be wiped dry and applied to it, pressing it down from above and taking care not to move it from its original position. The pressure should be applied especially to all regions which, like the center of the palm, are naturally raised above the level of the other parts, and the fingers should be spread a little apart and pressure applied between them. In removing the member from the inked surface hold the corners of the latter and lift it quickly, beginning at the wrist or heel. By now placing the member in the same position upon a clean piece of paper and by repeating the pressure and other manipulations a print will be obtained. Finally, a little turpentine may be used to clean the roller and the surface of the skin.

Prints formed by the above methods reproduce the exact course of every papillary ridge and may be studied at ease, drawn upon and compared with one another in ways never possible in the case of the actual surfaces; besides which, the contrast of the black ridges with the white interstices (white if the ink has not been used too plentifully) causes the markings to show with far greater distinctness than when presented in the uniform tints of the natural flesh.

In order, however, that such a print should furnish much instruction, it should be interpreted, that is, mapped out morphologically into its natural areas, a proceeding which is always the first step in the study and which causes the prints to appear somewhat as in the examples given in Fig. 6. In the case of the hand, such an interpretation should begin by the determination of five fixed points, or tri-radii, four of which, the *palmar tri-radii,* are below the bases of the four fingers and

* Published by Macmillan & Co., 1892.

the fifth, the *carpal tri-radius,* low down near the wrist and of more uncertain occurrence. These tri-radii are points about each of which three sets of ridges come in contact, their boundaries forming links which radiate from the point at about equal angles from one another. In some cases there will be produced in this way a small triangle of neutral ground from the angles of which the three lines proceed, while in others the three radiating lines proceed from a point.

When these points are determined the palm is marked out into areas by simply continuing the radiating lines until they pass beyond the margin or coalesce with one another, a proceeding best followed at first with a finely pointed hard black pencil, and afterward repeated for the sake of clearness with a colored pencil, preferably red. In tracing these lines it will be noticed that they often follow the interspaces and not the ridges, and that these latter often break or fork, sometimes causing a moment's consideration concerning the best direction to follow. A lens may occasionally be used to advantage, but usually it is better in doubtful cases not to scrutinize the details too minutely, but to let the lines of interpretation follow the general trend of the markings, rather than individual spaces or ridges.

When the interpretation is complete it will be seen that the palm is separated into its elemental areas as in the illustration given in Fig. 6. The two short lines going up between the fingers from each of the palmar tri-radii are termed the *digital lines,* and serve to limit the small triangular *digital areas;* while the third set of lines, usually more extensive, form the *four primary lines* and run across the palm, marking the boundaries of the *three palmar areas.* When a carpal tri-radius is present, its extensions define a *carpal area* adjacent to the wrist and also separate the two largest areas, the *thenar* and the *hypothenar*; in cases where it is wanting, a slight divergence of the lines in about the middle of the wrist at the margin of the palm shows the point from which the line should be drawn that separates the two latter areas. Such a case may be termed a 'parting,' and where this occurs there is no definite carpal area.

These, then, are the elements into which a human palm may be divided, and among these there is the greatest conceivable variation, both of size, arrangement and mutual relationship. If even a small collection of interpreted prints be made and compared (Fig. 6), they will be found to be absolutely individual and distinct, the differences being due to variations in the elementary areas, both in themselves and in their relationships to one another. This variation is so great that it seems at first to be entirely without system, and much like the detailed though purposeless descriptions of the palmist, whose classification of the wrinkles and other features,

though worked out into the minutest details, is wholly artificial and arbitrary; yet the exact correspondence of the areas with the patterned mounds of the monkey palm show that we are dealing here with definite morphological parts, and the variations that occur are caused by reduction, hypertrophy, fusions, separations and other principles with which the morphologist is familiar.

Thus, considering the three palmar areas alone, they will be found either all *distinct* (Fig. 6, *a* and *b*) or two of them may be *confluent* (Fig. 6, *c*, P_2 and P_3), or *semi-confluent* (Fig. 6, *d*, P_1 and P_3). They may be *open, i. e.*, may extend to the margin (Fig. 6, *b*, P_1 and P_2) or *closed* (Fig. 6, *c*, P_2 and P_3). Semi-confluent areas may also be termed

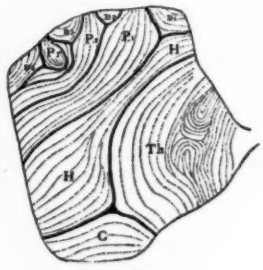


FIG. 6a.

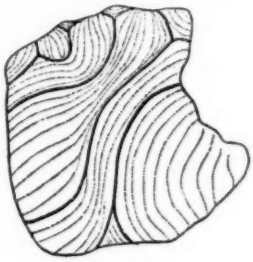


FIG. 6b.

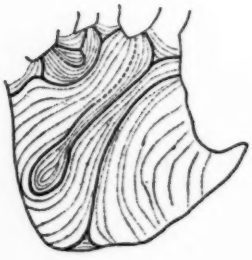


FIG. 6c.

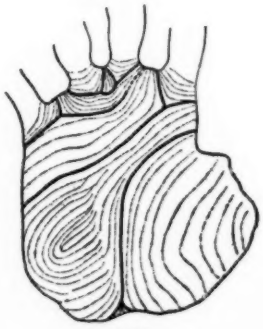


FIG. 6d.

FIG. 6. TRACINGS OF FOUR PALM PRINTS, TO ILLUSTRATE VARIOUS MODIFICATIONS.

divided, since this condition is brought about by the division of one of the areas by a primary line, and in the same way a single closed area (Fig. 6, *b*, P_3) may be termed *circumscribed,* since this condition is brought about by the fusion of the two primary lines which serve as boundaries.

In size an area may vary between a very large one (Fig. 6, *b*, P_1) and a greatly reduced one (Fig. 6, *d*, P_2), and in the latter case the reduction may become so extreme as to end in the complete loss of an area, a condition which would be obtained if we should consider the second and third palmar tri-radii of Fig. 6, *d*, which are here very near

together, to approximate still closer until they became entirely coincident, a condition not infrequent.

These modifications of areas may be readily expressed in terms of the primary lines which determine and bound them, and as each of these four lines possesses a large number of possible positions, they may be made the basis of a classification by which an individual palm not only might have a definite place in a series, but might also be conveniently designated and briefly described; furthermore, the terms constantly occurring in such a description might be expressed by obvious symbols, thus reducing it to a simple formula. To illustrate this the four palms given in Fig. 6 may be described in terms of the primary lines as follows:

(*a*) Line 1, open to margin; line 2, open to margin; line 3, fused with eighth digital line; line 4, recurrent, dividing third palmar area.

(*b*) Line 1, open to margin, low; line 2, open to margin; line 3, fused with line 4; line 4, fused with line 3.

(*c*) Line 1, involved in pattern, returning above; line 2, fused with line 4; line 3, recurrent, dividing third palmar area; line 4, fused with line 2.

(*d*) Line 1, open to margin; line 2, fused with line 3; line 3, fused with line 2; line 4, dividing first palmar area.

By the employment of a few obvious symbols these descriptions might be transformed into formulæ, as, for example:

(*a*) $0-0-d_4-\frac{P_3}{4}$

(*b*) $0-0-+4-+3$

(*c*) In H ret. above $-+4-\frac{P_3}{3}-+2$

(*d*) $0-+3-+2-\frac{P_1}{4}$

This exposition of individual differences in the course of the papillary ridges, and the suggestion of methods of recording, interpreting and describing them, leads us away from the realm of morphology to that of their practical use in establishing personal identity and thus brings us to the work of Mr. Francis Galton, who by the patient observation of a long series of years has elaborated a system by which personal identification may be established by the use of the apical patterns. As a result, primarily, of the suggestions of Sir William Herschel, Galton in his anthropological laboratory at South Kensington, has spent years in collecting data for his work, and to him belongs the entire credit of having established the two essential facts upon which all claim to the value of such markings in the point at issue must rest, namely; (1) their absolutely individual character, and the impossibility of an exact duplicature in two individuals and (2) their permanence throughout life.*

* See for this Galton's numerous publications on the subject and especially his two books on 'Finger Prints' and 'The Decipherment of Blurred and Indistinct Finger Prints.' Macmillan, 1892–94.

That the method of employing the prints of the apical patterns in identification, as advocated by Galton is, in the hands of an expert, an exact one, there can be no doubt, and it has been already accepted by the English government and introduced in the province of Bengal and a few other places, proving a dangerous rival to the more obvious but less accurate system of Bertillon, which depends upon various physical measurements; but the disadvantages occurring from the minuteness of the parts upon which the observation depends and the necessity of a lens, obstacles which would demand in all cases the employment of a trained expert, would necessarily limit the application of such a system to a few places where adequate means could be furnished.

As a practical extension of the Galtonian system; one in which the minute details of the apical patterns are replaced by larger and more definite markings, the present author advocates the use of prints, *not only of the whole palms, but of the soles as well,* a system in which in the vast majority of cases the cursory study of the main lines and areas alone would be sufficient, while only in the almost impossible case of general correspondence in the markings of two individuals in all four members would resort to what Galton terms the 'minutiæ' be necessary. In the collection of one hundred palm prints alluded to above, there are but two or three cases where the general formula is the same in the hands of the same side, and in these the other hands and the two sets of soles are widely different. If this should prove to be about the usual average, then an identity of general plan, that is a similar course in the four primary lines, may be expected to occur once in every 25 left hands. Continuing this line of reasoning, the chance of the coincidence being repeated in the right hand would be but 25^2, or 625, and if the same figures be true of the soles, then in complete sets the chance of correspondence in the gross details would be 25^4, or once in 390,625 times. But such 'identity' is by no means a complete one and really means, not an identity at all but a general similarity in the course of the four primary lines and in the areas defined by them. If such very obvious details as the occurrence of patterns, or the condition of the carpal area be also taken into account the chance of coincidence would be many times decreased. Furthermore, as Galton has conclusively proved by careful statistical study of the apical patterns, even in those identical in general plan, the 'minutiæ,' that is, the disposition, number and length of the ridges forming the patterns are always very different.

Aside from this, another line of proof of the impossibility of complete duplicates is furnished by an examination of the hands and palms of so-called 'identical' twins, or twins which are of the same sex and otherwise closely resembling one another. In such cases we have a strong biological warrant to expect a closer resemblance in these

and all other parts than could possibly be the case with any other two individuals, but even here, although the correspondence as to the general formulæ is, as a matter of fact, identical or nearly so, the variation in proportions, in the number of ridges forming a given area, and in other similar details, is so great that no one would be deceived into considering them really identical.

If the use and practical application of the system above outlined may be briefly alluded to here, it will be seen that the cases where such a system would be of great importance are numerous and varied. Aside from the case of criminals where the possession of a set of prints by the authorities would be a far better and surer guide than the usual 'Rogues Gallery' photograph or even a set of Bertillon measurements, there are cases of accidents of various sorts in which the bodies may be sufficiently mutilated to render recognition uncertain or impossible; cases of claimants of estates, like the famous Tichbourne claimant; cases of the supposed restoration of lost children, and many others.

With regard to criminals, prints could be made and filed away at headquarters, as is now done with photographs and written descriptions, for in the case of a suspect who has taken refuge under an *alias,* the mere hesitation to submit to the process would increase suspicion, and one could have no just ground for refusal. Should a refractory case occur, the use of chloroform would violate no principle of humanity, and the mere threat of it would be apt to enforce compliance.

In accident cases, as in the classical one of Jezebel, to whom Galton has feelingly alluded, the palms and the soles are apt to be the last external parts to be destroyed, being protected respectively by the involuntary clenching of the hands and by the heavy soles of the shoes. With regard to the durability of the epidermic ridges Galton states that they are still present and plainly seen in many Egyptian mummies and in an experiment made by the author upon the feet of an infant belonging to the prehistoric cliff-dwellers of southern Utah, where the bodies were not even embalmed but simply dried in the rarefied mountain air, the thenar and apical patterns could be definitely traced after a comparatively simple preliminary treatment.

To provide for both accident cases and those involving all forms of claimants, it would be a very simple matter for families to take and preserve a set of prints of each individual, although it would be still better, as in all cases of public versus private supervision, if each community were required by law to add such a set of prints to the birth records of each of its citizens, records which could be easily taken at the entrance to the public schools or at some other definite time when the child is old enough to voluntarily assist in the process. These records could be easily duplicated by photography if wanted for com-

parison at a distance, but in most cases the sending of the formulæ either alone or with the addition of a few details would suffice, and could be easily telegraphed.

To insure the rapid selection of a given print, especially in a large collection, some method of classification other than by name and family would be requisite and this could be done by filing the actual prints alphabetically and making a card catalogue of the formulæ and descriptions, the arrangement of which would depend upon certain features selected from these.

By such means it would be easily possible to keep even a great number of records in a very compact form, and in the larger towns and in cities this would demand the use of a special room in the municipal building and the maintenance of a clerk to take and file the prints and to be on hand for consultation in case of need, yet the small expense involved in this would be trivial in comparison with the large amounts which would often be saved by a prompt and accurate determination.

It is, then, a matter of certainty that a system of personal identification founded upon the epidermic markings of palms and soles would endure all the tests required of such a system and would be in point of absolute accuracy, rapidity of application, simplicity and convenience in classification much superior to any system now in vogue. Its uses would be as numerous as are the cases in which the identification of a body, living or dead, becomes for any reason a matter of importance and it may be prophesied that the countless cases where doubt, uncertainty and great expense are involved, and which are now of constant occurrence, may be ultimately prevented through its establishment.

TOWARDS THE NORTH POLE.*

THE collapse of Mr. Baldwin's expedition by Franz Josef Land and the return of Commander Peary and Captain Sverdrup from their abortive attempts to reach the Pole from the American side may make it interesting to give a brief account of the various efforts that have been made to push northwards towards this goal during the last 400 years. Mr. Baldwin's richly-equipped expedition was frankly stated to have as its almost sole object a dash at the Pole, and although both the expeditions of Commander Peary and Captain Sverdrup had other and more substantial objects in view, still, in each case, these were to be combined with an attempt to pass all previous records in this direction. We await details of Captain Sverdrup's proceedings, but it is improbable that he has attained anything like the latitude achieved by Commander Peary.

During the latter half of the sixteenth century and the early years of the seventeenth, when so many stages of the long journey to the North Pole were covered, great progress was made in that section of the north polar area which lies to the north of Europe and includes the extensive land masses of Novaya Zemlya and Spitzbergen. Sir Hugh Willoughby, in the *Bona Esperanza,* 120 tons, Richard Chancellor, in the *Edward Bonaventure,* 160 tons, and Cornelius Durfourth, in the *Bona Confidentia,* 90 tons, first led the way in 1553. The first two vessels reached Kolguev Island, or as some claim even the south-western shore of Novaya Zemlya, in about 72° N. latitude; but the extent of the voyage is uncertain, as in the following winter all on board, numbering some 62 souls, miserably perished of cold and hunger. There is no doubt, however, that Stephen Burrough in the *Searchthrift* pinnace reached 70°20′ N. latitude in 1556 and sighted the coast of Novaya Zemlya. The next great step northwards in this direction was made by the Dutch mariner, William Barents. Sent by the merchants of Amsterdam in the *Mercury,* 100 tons, to discover a passage to China round the north of the island, he sighted on July 4, 1594, the west coast of Novaya Zemlya in 73°25′ N. latitude. Continuing his journey, he passed the northern limit of the island, finally reaching Orange Island north of the 77th parallel. Two years later another stage in the direction of the Pole was covered. A Dutch expedition comprising two vessels, Barents being chief pilot of the one and Cornelius

* From the London *Times.*

Ryp in command of the other, sailed north past Bear Island to Spitzbergen, and in following its shores, then explored for the first time, reached a latitude of close on 80° N. Even this high northing was surpassed, however, by Henry Hudson in 1607, who, in a little vessel of 80 tons, the *Hopewell,* followed the Spitzbergen coast to a point by dead reckoning 81° N. Land was stated to have been seen as far north as 82°, but either the reckoning must have been erroneous or ice must have been mistaken for land. In 1612, however, Jonas Poole met at Spitzbergen Thomas Marmaduke, of Hull, in the *Hopewell,* who, Poole states, sailed as far north as 82°, two degrees beyond Hakluyt's Headland. If this statement is well founded, no further advance towards the Pole was made in this or any other direction—that is, no well-authenticated advance—for considerably over 200 years. But if Marmaduke's claim is allowed, so must be the claims of the Dutch and other whalers, large numbers of whom for many long years thought nothing of passing 80° N. latitude, and in favorable seasons may possibly have reached a degree or two higher. Confining our attention, however, to authenticated records, and remembering that the highest northing calculated from observations that was reached by Hudson was 80°23′, we may mention, in this brief record of the stages passed in the journey northwards, the expedition sent out by the Admiralty in 1773 under Captain J. C. Phipps (afterwards Lord Mulgrave). Phipps reached 80°48′ N. latitude off the northwest coast of Spitzbergen. It is interesting to note that this was the polar expedition on which Nelson served. A more marked advance was made in 1806, when the famous whaler, William Scoresby, was able to advance good proof that he had reached 81°30′ N. latitude in the Spitzbergen Sea.

But it was reserved for Lieutenant W. E. Parry far to outdistance all his predecessors in the work of north polar exploration. Parry set sail in the *Hecla* in 1827, and making Trureaberg Bay, on the north coast of Spitzbergen, his base of operations, started northwards with two boats, which were fitted with steel-shod runners so that they might serve as sledges. In spite of the toilsome nature of the journey, he and his men pushed over the ice, piled with great blocks and bristling with splinters which pierced through boots and feet, to latitude 82°45′ N. Then it was found that the southerly drift of the ice practically counterbalanced the progress made during the onward march and the expedition was compelled to turn back. Before Dr. Nansen's ever-memorable expedition, Parry's was the highest northing attained in the Eastern Hemisphere. But it may be noted that the Austrian Lieutenant Julius Payer, who, in conjunction with Lieutenant Carl Weyprecht, discovered Franz Josef Land in 1873, reached in the following year the highest point on land yet attained in the Eastern Hemisphere, in 82°05′ N. latitude. Neither Mr. Jackson, Mr. Well-

man, nor Mr. Baldwin established a record. Dr. Nansen's famous journey in 1893–96, on which the explorer made so great a stride towards the Pole, is still fresh in the minds of all. Here we will only recall that the *Fram,* after entering the ice near the New Siberian Islands, touched the 86th parallel in the course of her long drift westwards, while Dr. Nansen himself and Lieutenant Johansen, having left the ship in 84° N., finally reached (at least) 86°5′ N., in longitude roughly 90° E. Two years ago this record was surpassed by Captain Cagni, of the Duke of the Abruzzi's expedition, who reached 86°33′ N. latitude, the highest northing yet attained in either the Eastern or the Western Hemisphere.

Hitherto the passage north through Behring Strait has not led any traveller to very high latitudes. Behring himself discovered neither the strait nor the sea that bear his name. His utmost northing was 67°18′, attained on his first expedition in 1728. Exactly 50 years later Captain James Cook, the great navigator, reached 70°44′ north, and in 1826 another British naval officer, Captain F. W. Beechey, who had been told off to cooperate with Franklin in his researches on the mainland of North America, attained the latitude of 71°08′ N. Beechey's mate, Elson, pushed 126 miles beyond Icy Cape to Point Barrow, in 71°24′ N. latitude. In 1849 Captain Kellet reached the first island to the north of Behring Strait, in 71°18′ N., and six years later Commander John Rodgers, of the United States navy, surpassed Elson's latitude, his northing being 72°05′. But the highest latitude recorded in these seas was that attained by Commander G. W. De Long, of the United States navy, to the north of the Liakoff or New Siberian Islands. This group had first been reached from the north coast of Asia in 1770, by a Russian trader named Liakoff, and in 1823 Lieutenant P. F. Anjou, who since 1820 had been exploring among the islands in company with Lieutenant F. von Wrangell, had succeeded in getting as far north as 76°36′. De Long sailed through Behring Strait in the ill-fated *Jeannette* in 1879. The pack-ice was entered near Herald Island in 71°35′ N., and for two years the vessel drifted westward and northwards. Wrangell Land, which De Long had thought was part of a continent, and on which he expected to winter, was passed in the summer of 1779; in June, 1881, Jeannette Island in 76°47′ N. latitude was reached; later in the same month Henrietta Island, in 77°08′ N. was passed, and then the *Jeannette* was crushed in the ice. The survivors drifted north to 77°36′, the highest northing yet attained in those seas. How at last the north coast of Asia was reached, and how all but Chief Engineer Melville and eleven of the crew perished, does not here concern us.

Only a slightly, if at all, higher latitude than that reached by De Long has been attained by travellers following the east coast of Green-

land. Hudson sighted this coast in 1607, in about latitude 73° north, and, according to the old Dutch chart of Gerrit van Keulen, as high latitudes were attained during the course of the seventeenth century as have ever since been reached in this direction. In 1654 Gale Hamke found land in 74°30′, in 1670 Lambert touched 78°30′. So difficult is the East Greenland coast of approach, however, and so little was known about it in the early years of last century, that the famous whaler, Captain William Scoresby, son of him whose northing off the coast of Spitzbergen we have already recorded, may well be said to have advanced a stage towards the Pole in this direction when in 1822 he surveyed and charted the coast comprised between latitude 73°30′ north and latitude 75° north. In the following year Captain Clavering, assisting Captain Edward Sabine, in his great pendulum work, reached Shannon Island in 75°12′ north, and saw the coast stretching as far as the 76th parallel. No higher northing was made until the second German North Polar Expedition visited the coast in 1869. After wintering on Pendulum Island, Koldewey and Payer followed the shore northwards in sledges, and in April, 1870, reached the extreme northing along the East Greenland coast—if we except that with which Lambert is credited on the old Dutch chart—of 77°01′. The stretch of coast between this and Peary's furthest on the north coast of Greenland still remains uncharted, though both Peary and Sverdrup professed to have its survey in view as one of their objects. None of these latitudes can compare with those attained by way of the Spitzbergen and Franz Josef Land routes. Indeed, the only route which may be said to rival these latter in the facilities it affords for approaching the Pole is that which runs between the west coast of Greenland and the vast land masses lying to the north of North America. In this direction the first stages of the long journey towards the Pole were covered by the expeditions which began to be despatched towards the close of the fifteenth century in search of a Northwest passage.

Leaving out of account the two uncertain records connected with the names of the two Cabots, as well as the unfortunate enterprise of Frobisher, we come to the brave John Davis, who made a great stride northwards. After twice barely crossing the Arctic circle, in 1585 and 1586, he set out a third time, in 1587, from Dartmouth. The expedition comprised three small vessels, the two larger of which were left near Gilbert Sound, while Davis pushed ahead in the third, a mere pinnace. On June 24 he reached 67°40′ N. latitude, and saw many whales, and on the 28th attained his highest northing, 72°12′, where be found the bold promontory which he named Cape Hope Sanderson. Hudson, of course, was far to the south of this in Hudson Bay, and it was reserved for William Baffin to reach what was, for more than two

centuries, the most northerly point attained by this route. Robert Bylot, master, and William Baffin, pilot, set out from Gravesend in 1616, with 15 men on board the *Discovery,* 55 tons. Proceeding along the west coast of Greenland, they reached Cape Hope Sanderson on May 30. As they continued north, Women's Island was found and named in 72°45′. In 73°45′ the expedition was detained for a short time among natives of Horn Sound, but the ice broke up, and on July 1 an open sea lay before the travellers in 75°40′ N. Pushing across this, the expedition reached the entrance to what was named Sir Thomas Smith's Sound, and an extreme northing of 77°45′ was recorded.

When one takes into account all the attendant circumstances, this was really a most remarkable voyage, but, notwithstanding the success which attended it, Davis Strait and Baffin Bay were so neglected by explorers for the next two hundred years that when interest in this section of the north polar field revived, early in the nineteenth century, the narrative of Baffin's discoveries was quite discredited. The accuracy of his observations was soon confirmed, but not until 1852—unless it may have been some whaler—did any one push our knowledge of the Arctic regions in this direction a stage nearer the Pole. In that year Captain E. A. Inglefield, in the *Isabel,* coupled with a summer search for Franklin an attempt to ascertain whether Smith Sound was connected with the Polar Sea. On August 26, the expedition reached Cape Alexander, the most northerly point seen by Baffin, and Inglefield saw the open sea "stretching through seven points of the compass." He started to steam northwards, but twelve hours later, when only forty miles beyond Baffin's furthest, was turned back by the ice. His extreme northing was 78°21′. In the following year the Americans took the field. Elisha Kent Kane, in a vessel fitted out by Grinnell and Peabody, straightway broke the new record and reached and wintered in Rensselaer Harbor, 78°37′ N. In the summer of 1854 the surgeon of the expedition, Isaac I. Hayes, crossed Kane Sea to Grinnell Land, which he traced to Cape Frazer, 79°43′ N. In the meanwhile, on the Greenland side of Kane Sea, two other members of the expedition, William Morton and Hans Hendrik, reached and scaled the south side of Cape Constitution, in 80°35′ N., overlooking Kennedy Channel. These results were the more praiseworthy in that the expedition suffered terribly from scurvey and in other ways, and barely succeeded in reaching the relief expedition that rescued them in 1855. C. F. Hall was the next traveller to push back the line dividing the known from the unknown. Though neither a sailor nor a scientist by profession, he possessed all the qualities of courage and perseverence and endurance which go to the making of a great explorer, and, favored by an exceptionally open season, he succeeded, in 1870, in pushing right through Smith Sound, Kennedy Channel, and Robeson Channel

to the polar sea beyond. Heavy pack-ice stopped his advance in 82°11′ N. latitude. His vessel, the *Polaris*, wintered under an enormous floeberg in 81°37′ north. Before winter really set in Hall journeyed by sledge northwards to the 82d parallel, and there saw land on the west side of Robeson Strait, extending north, as far as he could judge—and subsequent observations practically confirmed his estimate—to about 83°05′ N. During the winter Hall died, and the other members of the expedition only escaped after experiencing a succession of disasters.

But the success which had attended the efforts of the expedition to reach a high northern latitude and the other valuable geographical results obtained, roused a spirit of emulation in this country. In 1875 was despatched the famous Nares expedition, in the *Alert* and the *Discovery*. They found all plain sailing as far as Cape Sabine, but beyond that point the ice conditions were as unfavorable to an advance northwards as Hall had found them favorable. By degrees, however, the *Alert* and the *Discovery* made their way along the West Greenland coast past Cape Lieber and across Lady Franklin Bay to Discovery Harbor. Here the *Discovery* wintered, but Nares, pushing north in the *Alert*, managed before the close of the summer to advance a step nearer the Pole than any who had previously followed the Smith Sound route. His winter station on the edge of the Polar Sea was in 82°25′ N. But even this high northing was not to mark the limit of the expedition's success that year. Lieutenant Pelham Aldrich, whilst in command of a sledging party, reached on September 25, 1875, latitude 82°48′ north, on the coast of Grinnell Land, and established what was then a world's record. In the following summer Aldrich was yet more successful, passing round the north end of Grinnell Land from Cape Columbia, in 83°07′ north, to Cape Alfred Ernest, in 82°16′ north. Meanwhile Commander A. H. Markham was attaining still higher latitudes. After following the coast to Cape Henry, in 82°55′ N., Markham struck across the ice-bound Polar Sea in a direct attempt to reach the North Pole. He was accompanied by seventeen men, with two sledges, and after almost superhuman exertions reached a latitude of 83°20′. On the valuable work accomplished in other directions it is not now our purpose to dilate. It is curious to note, however, when one bears subsequent expeditions in mind, that the Nares expedition, successful as it undoubtedly was, was supposed to have closed that particular route to the Pole. "To send another expedition in that direction would," it was declared, "be a waste of money and energy." In spite of this dictum, the Greely Expedition, sent north by the United States Government as a result of the International Polar Conferences of 1879–80, made its way up Smith Sound in 1881. The expedition remained in the polar regions three years, and carried out a series of

very important scientific observations. But here we have only to record that it covered yet another stage of the long journey to the Pole. In April, 1882, Lockwood, with eight companions, started north from Newman Bay. Repulse Harbor was reached in five days after great exertions. From this point the conditions of travel were most trying, but the little party pressed on to Cape Bryant, where Lockwood decided to continue the journey with only Brainard and one of the Eskimo. Gradually they crept northwards. Towards the end "floes so high that the sledge was lowered by dog traces," ice so broken that the axe cleared the way, and widening water cracks in increasing numbers impeded progress; but, despite all obstacles, they reached, May 13, 1882, Lockwood Island, 83°24′ N., which remained the highest northing until Nansen made so great an advance towards the Pole.

Commander Peary's magnificent record has already been detailed in these columns. Here we need only recall that Peary set out on his last great expedition in the summer of 1898. Having come to the conclusion that no further advance was to be effected by way of the Greenland inland ice, he determined to push north through the great waterway that lies between the west coast of Greenland and the vast island masses lying to the north of the Dominion of Canada. Peary sailed in the *Hope,* and was followed by the *Windward,* which had been generously presented to him by Mr. Alfred Harmsworth. The two ships obtained some walrus in Whale Sound, between Hakluyt Island and Littleton Island, and then, while the *Hope* returned south, Peary turned the prow of the *Windward* northwards and endeavored to reach Sherard Osborne Fiord in Kennedy Channel. But the season was unfavorable, and Peary was compelled to winter 150 miles south of his objective, near Cape d'Urville. Leaving the ship towards the close of the year, Peary journeyed by land to Fort Conger, the headquarters of Greely's famous expedition, mentioned above. But this attempt to utilize the winter months for travelling delayed rather than advanced the expedition. In a terrible snow storm which overtook the little party, on New Year's Day, Peary suffered badly from frost bite, and on his arrival at Fort Conger it was found necessary to amputate seven of his toes. After this it was, of course, impossible for him to make any serious attempt to reach the Pole in the spring of 1899. Peary, however, had himself drawn about in a sledge, so that he might become accustomed to the conditions of travel in that region, and then, returning to the *Windward,* sailed for the Eskimo encampment at Etah, near Cape York. Here he found the *Diana* awaiting him with supplies. These were landed, and then both the *Diana* and the *Windward* sailed south, leaving Peary to winter at Etah and make an attempt to reach a high northing in the spring of 1900. A start was made from Etah on April 15 of that year. Following, apparently, the west coast of

Greenland, Peary passed Lockwood's farthest north between three and four weeks later. The coast was found to run north some ten miles further to 83°39′ N. latitude, where it turned abruptly to the east. Striking across the great Polar Sea, Peary struggled on to 83°50′ N., where he was turned back by a considerable expanse of open water. Before he returned to headquarters, however, useful work was accomplished along the North Greenland coast, which was surveyed as far as Independence Bay, the point reached by Peary on his two great journeys across the inland ice-cap in 1892 and 1895. The winter months were spent partly at Fort Conger, partly at Meat Caches, 250 miles to the north.

Another attempt to reach the Pole in the spring of 1901 had early to be abandoned, as neither men nor dogs were in a fit condition to make any prolonged march. Peary accordingly made his way south, and on June 6 came across the *Windward* with Mrs. Peary and the explorer's little daughter on board. The *Windward* had gone north in search of Peary in the summer of 1900, and, failing to find him, had wintered in Payer Harbor near Cape Sabine. Here, too, in 1901, came the *Erik* in search of the *Windward*. Disappointment was naturally felt when it was found that Peary has failed to reach the Pole, or even to attain a higher northing than that of Nansen and Cagni in the Western Hemisphere. The strain of so long a sojourn in the Arctic regions had naturally been great upon a man of even Peary's iron physique and dauntless courage, but the explorer determined to make one last effort this year. Both the *Windward* and the *Erik* sailed south in August, 1901. So far as can be made out from the telegrams to hand, Commander Peary has followed, as far as practicable, the plans which he had laid down according to the information brought home by the *Erik*, which left him on August 20, 1901, in his temporary camp on the south side of Herschel Bay, on the west side of Smith Sound, about a dozen miles southwest of his permanent quarters at Payer Harbor, near Cape Sabine, about 78°45′ N. He was then stated to have been well provided with all necessaries, although the difficulty of taking sufficient food for the dogs was regarded as rather a serious one. It was also stated that he intended to take with him a "marine equipment," so as to be able to cross open water wherever it should occur. The telegrams to hand do not refer to a boat as part of the equipment, but, as open leads of water were met with, it is presumed that the expedition had some means of crossing them.

The move northwards began with the advance party of six sledges in charge of Peary's faithful colored companion, Henson, on March 3, followed three days later by the main party with 18 sledges. These parties, no doubt, traveled northwards along the ice foot on the American side, close to the shore, the distance to Fort Conger on the north

shore of Lady Franklin Bay, which was the headquarters of the Greely expedition, being some two hundred miles. Fort Conger lies about 81°50′ N. Apparently little time was spent at Fort Conger, and a fresh start was made for Cape Hecla, which lies a little to the south of the 83d parallel, to the northwest of the northern end of Robeson Channel. If, as is probable, the journey continued to be made along the ice foot, the distance to be covered was not far short of one hunderd miles. Evidently the water right across to Greenland in this channel was remarkably open, while open stretches of water were visible as far as could be seen to the north. From Cape Hecla a start was made on April 1 to face the serious task which Commander Peary had set before him—an advance northwards, if possible, to the Pole. Commander (now Admiral) Markham's furthest north, 83°20′26″, was reached on May 12, 1876, at 64° W. longitude. Markham started from Cape Joseph Henry in 82°55′ N. on April 10, so that he took one month to reach his furthest point about thirty miles to the northwest of his starting point. The difficulties which he met with in trying to surmount the hills of palæocrystic ice which had been thrown up along his route seem to have been greater than even those encountered by Peary. And it should be remembered that Markham had no dogs, and only two sledges and 17 men. The same palæocrystic ice, due to pressure and the piling up of floe upon floe, seems to have been met with by Peary, although he encountered open leads of water and floes in motion. Although he only reached 84°17′ N., about 75 miles to the northwest of his starting point, in order to accomplish this he seems to have been compelled to make long detours. But, as further progress with the means at his disposal was utterly impossible, he had to give up, and was back at Cape Hecla again on April 29, and at his headquarters at Cape Sabine about a fortnight later. Although Commander Peary seems to have met with more open water than did Commander Markham, still the conditions here seem to have been essentially the same as they were in 1876. The vast masses of ice which come down from the north have no adequate exit south of 83° N., so that they are bound to accumulate under the immense pressure that must take place, and so produce those palæocrystic ice ranges which seem to render advance impossible in this direction. It is possible that, had Commander Peary had more abundant means at his disposal, and been able to continue still further to the north, he might have found the conditions more favorable; but the record of this, as of previous attempts in the same direction, seems to confirm the opinion of distinguished Arctic authorities that the Pole is not to be reached by this route. No doubt Commander Peary will have an exciting story to tell, but those interested in the advance of knowledge will anxiously await details of the abundant scientific results which he is reported to have accomplished. Mean-

time, although he holds the record on the American side of the Polar area, on the other side he has been surpassed by Captain Cagni by over two degrees—about 150 miles.

With regard to Captain Sverdrup, who left Godhavn, in Greenland, on August 8 and has just arrived in Norway, it is evident that he has been quite unable to carry out his somewhat ambitious program, which, besides getting as far north as possible, included a survey of the northeast coast of Greenland. When last seen, in 1899, the *Fram* was making for Jones Sound (misprinted Soner Sound in the telegram) and to that region he seems to have devoted his attention during the past three years. On the north of Jones Sound lies Ellesmere Land, about which we know but little. Captain Sverdrup has apparently surveyed the south and west coasts of that region, and if he has carried his explorations far enough north and west to connect with the results of previous expeditions he will have accomplished a fair amount of good work. But unless he has done much more it can hardly be said that he has fulfilled the expectations of his many admirers and friends. But before expressing any opinion on the results of the expedition, we must await further information. In Jones Sound he certainly selected a region of which our knowledge is slight and defective. In a memorandum on the subject, by Sir Clements Markham, president of the Royal Geographical Society, some interesting information is given as to the progress of our knowledge in this particular region. Jones Sound was discovered by Baffin in 1616, but no other expedition approached it until that under the command of Sir John Ross in 1818. In 1848 a Scotch whaler sailed up the Sound for a hunderd miles, until stopped by ice. In 1851 it was explored by Admiral Sir Horatio Austin who was stopped by ice about 60 miles from the entrance. In 1852 he was followed by Captain Inglefield, and from their explorations it became clear that Jones Sound was a channel leading to the Polar Sea, and not a mere bay or inlet. Possibly that is the reason which induced Captain Sverdrup to make his way into it with the *Fram;* but, as the Polar ice comes crowding down from the north among the numerous islands which seem to stud the sea to the west of Ellesmere Land, it is doubtful if a route in this direction is practicable.

Now that Peary and Sverdrup and Baldwin have all three returned from their abortive attempts to reach the Pole, the only expedition left in the Arctic region is that under Baron Toll, the well-known Russian explorer, who is at work in the direction of the New Siberian Islands, in search of what is known as Sannikoff Land, which is supposed to exist still further to the north. Of Captain Bernier's proposed North Polar expedition nothing has recently been heard.

In conclusion, Commander Peary's work in the interior of Greenland before his last great expedition ought not to be forgotten. His

additions to our knowledge of the Greenland ice-cap are very important, seeing how little is known of the interior of the country. Geological investigations carried out by Giesecke in 1806–14 along the west coast of Greenland for 60° N. to 73° N. form the basis of our knowledge of the geology of this vast island. The Danes have done much useful work along the southwest and southeast coasts, and the comparatively narrow strip of territory between the sea and the ice-cap is very well known from the 66th parallel on the east coast round to the 75th parallel on the west. Attempts to cross Greenland from west to east were early made. In 1728 Major Pars even set out at the head of an armed mounted force. But for long all attempts failed. Dalager, Rae, Brown and Whymper were unsuccessful in their efforts to explore the ice-cap. In 1870 Baron A. E. Nordenskiöld could only penetrate some 35 miles inland from the head of Auleitsivik Fiord, to an elevation of 2,200 feet. In 1878 Lieutenant Jensen reached a point 47 miles inland from Frederikshaab, where he found the ice 5,000 feet above sea level. In 1883 Nordenskiöld again visited Greenland, and made fifteen marches on the inland ice from the same point as before. He himself penetrated only a little way, but the Lapp ski-runners whom he had taken with him mounted the ice for 140 miles, reaching an elevation of 6,600 feet. At last Nansen effected the crossing from east to west. Umivik, the starting point, in 64°45′ N. latitude, was reached only after many hardships on August 10, 1888. By August 27 he and his companions, five in number, had ascended 7,000 feet, but only advanced forty miles. The ice-cap, however, was found to terminate in a broad flat plateau from 8,000 feet to 9,000 feet high, and over this such rapid progress was made that the west coast was reached, some fifty miles south of Goothaab, on September 29. Peary's crossings were effected in the reverse direction, and across the northern end of Greenland. After a preliminary journey from Disco Bay in 1886, Peary made his first attempt from McCormick Bay early in 1892, and, striking due northeast, came out on the north coast at Independence Bay. This journey was repeated in 1894, and briefly Peary may be said on these occasions to have determined the relief of an exceptionally large area of the inland ice, to have delineated the northern extension of the great interior ice-cap, to have demonstrated the insularity of Greenland, and to have proved the existence of detached land masses to the north. A valuable account was also obtained of the Smith Sound Eskimo.

THE DEVELOPMENT OF ECONOMICAL UTILITIES FOR HANDLING RAW MATERIAL.

By WALDON FAWCETT.

THE existence in crude form of some elementary devices for hoisting or otherwise handling certain classes of raw material, notably stone and logs, dates back many years, but it has been within the past decade and a half that there has taken place that remarkable progression which has constituted one of the most impressive achievements of the modern engineering world. Not only is bulk material, practically without limitation as to weight, hoisted to any height desired, but it has been rendered possible to transfer commodities at high speed for either long or short distances, and thus the mechanical operatives of the modern industrial world secure the trilogy of an economy of time, a saving of labor and the conservation of expenditures.

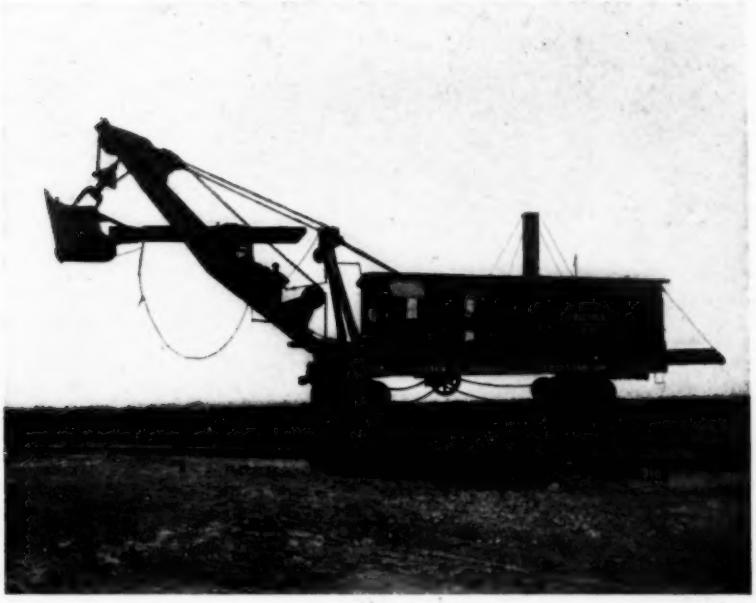
Easily the most interesting as well as the most significant advancement in this broad field is found in the introduction of improved methods for the handling of those two most important commodities—coal and iron, the latter embracing of course a variety of forms from iron ore to finished steel. Indeed, in the case of the most useful of metals there has been evolved a cordon of mechanical devices, the functions of which so supplement each other that from the time the ore leaves the mine until it has been transformed into marketable iron or steel the factor of manual labor directly applied, is practically eliminated.

The initiatory machine in this chain is found in the steam shovel which takes the iron ore from the 'open pit' mines of the Lake Superior district and later is called into requisition to transfer the ore from the stock piles at the mines to the railroad cars provided to carry it either direct to the blast furnaces or to the vessels wherein it will be given water carriage to the Great Lakes. The steam shovels for the latest approved practice range in weight from fifty-five to ninety-five tons and in this feature alone is afforded ample evidence of progress, for but a few years since the shovels of thirty-five or forty-five tons weight were deemed sufficient for all the exactions imposed by this work. The shovels now in use have dippers ranging in capacity from two and one half to five yards, and something of the celerity of movement with which they are operated may be appreciated from the fact that on many occasions ordinary railroad cars are loaded with ore and pushed out of the way of the machine at the rate of one every two minutes.

In the unloading of the immense cargo-carrying vessels of the

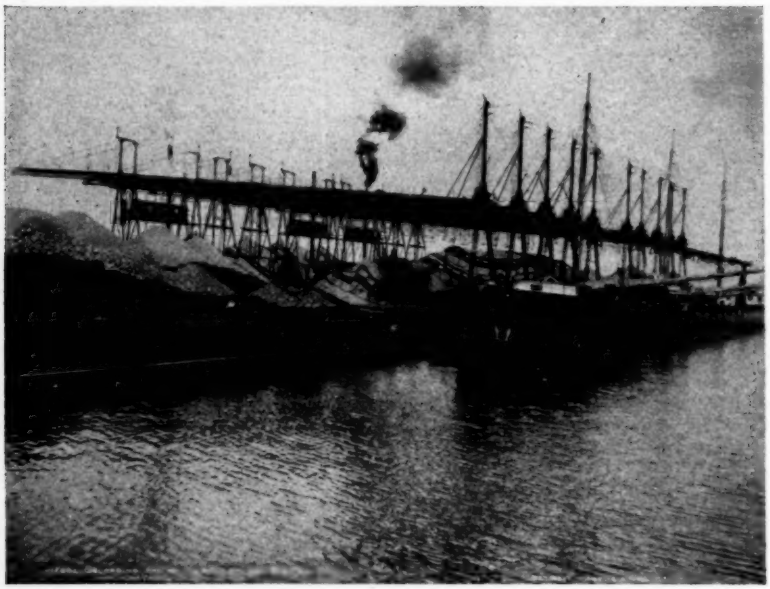
inland seas wherein the iron ore is conveyed from the Lake Superior mining district to the ports adjacent to the blast furnaces of the Middle West are employed the various forms of hoisting and conveying apparatus, all of American origin, which probably constitute the most famous of all the installations for transportation purposes. In this field of activity methods advanced, at a single step, from the old plan of unloading the vessels by means of wheelbarrows and permanent trestles to the bridge tramway structures which are up to the present date in almost universal use.

The conspicuous elements in any such installation embrace the elevated tramway—spanning the dumping ground or railroad yard and

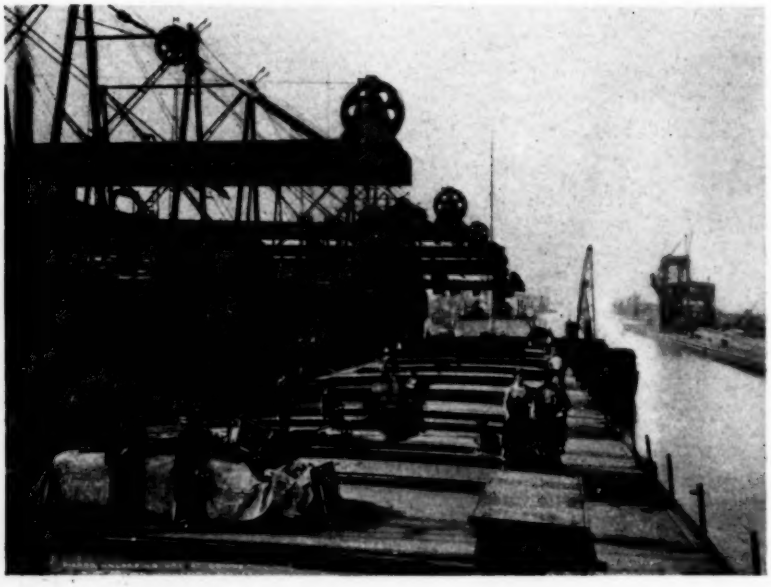


STEAM SHOVEL.

connecting it with the vessels—the trolley or carriage traversing this tramway and the system of mechanism by which the whole is operated and controlled. Such an apparatus is operated, of course, by a motive power located beyond the limit of travel, and while the operation is at every stage subject to the control of an operator, a large proportion of the important functions are automatic, the positive movements of the parts through such operations being derived entirely from the bodily movement of the apparatus itself, while actuated by momentum, gravity or the direct action of the hoist rope. Attached to the trolley of each machine is an automatic dumping-tub or bucket, the discharge of which may be made at the will of the operator, either at the



BRIDGE TRAMWAYS.

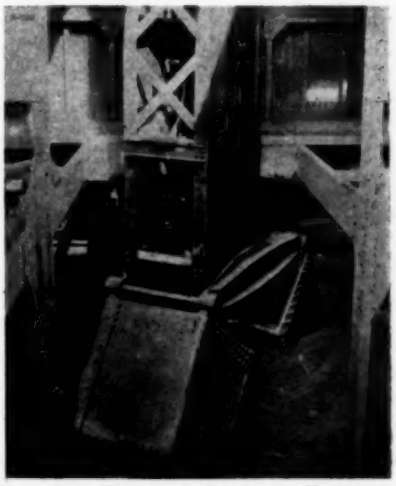


CANTILEVER APRONS EXTENDING OVER VESSEL

full height of the tramway or by an automatic deflection of their motion and with no appreciable loss of speed the buckets may be caused to descend and discharge their contents at any point below the tramway.

The bridge tramways are usually built in plants or groups of three or four bridges which may be supported on either single or double piers. The tramways are, as a rule, provided with hinged aprons designed to extend over the vessels and very frequently cantilever extensions are provided at the opposite end, so that the buckets are enabled to serve a space of 300 to 350 feet in width. The operation of the tub or bucket is effected by means of a wire cable connected with a drum in the engine room, and the engine is usually of the double cylinder type. The piers supporting a bridge tramway are on wheels, and it is thus possible to skew or move sideways the entire structure, in order to bring the bridges in line with the hatches of the vessel being unloaded. This type of machine hoists the bucket of ore from the hold of the vessel, conveys it to any desirable point on the tramway and automatically dumps the material on the dock or into waiting railroad cars.

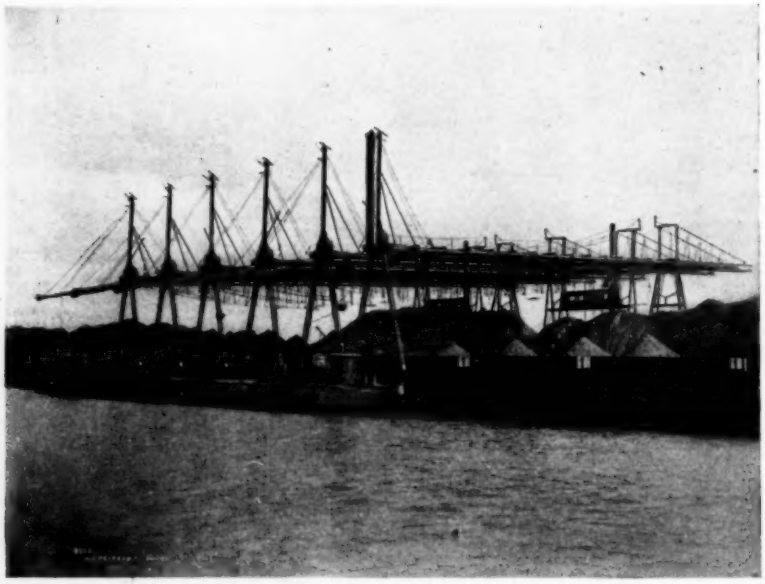
As indicating the capacity of the bridge tramway, it may be cited that a plant of three bridges will readily handle 1,200 tons of ore in a day of ten working hours, hoisting the material, conveying it a distance of 100 to 150 feet and dumping automatically. In the case of the bridges of exceptional length a round trip can be made from the hold of the vessel to the extreme end of the cantilever and back again, a distance of 600 feet in one minute, and in actual operations a rate of 45 seconds per trip has been maintained for hours at a time. The buckets or tubs for conveying ore are usually of one ton or a ton and a half capacity. There are several modifications of the bridge tramway system, notably cable tramways in which wire cables are substituted for the bridges and what are technically known as 'fast plants' wherein instead of the long bridges there are extremely short ones with tramway projections over the vessel and cantilever extensions over the railroad tracks on the dock, the effect of this short haul being to reduce tremen-



CLAM-SHELL BUCKET OF AUTOMATIC UNLOADER.

dously the lapse of time necessary for the transference of raw material from vessels to cars.

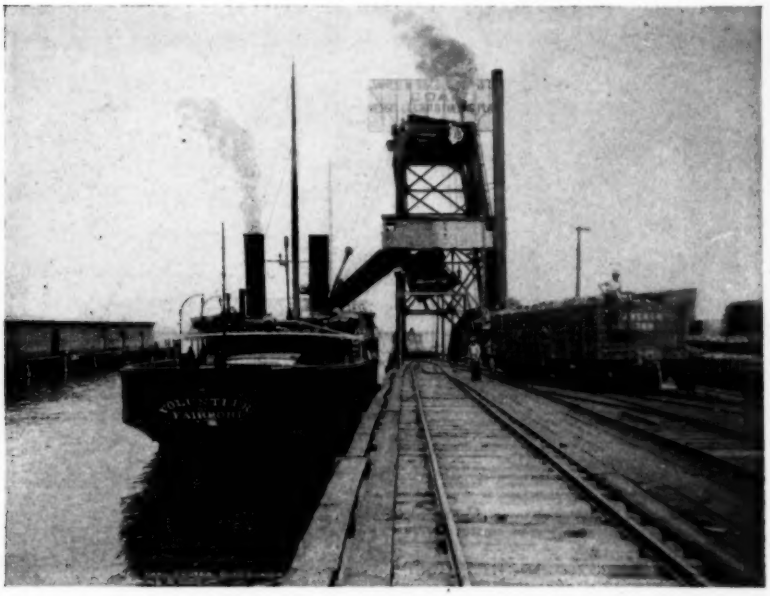
In the case of all forms of bridge tramway apparatus it is necessary to employ large gangs of men to fill by means of hand shovels the tubs or buckets carried by the trolleys and naturally therefore there is in the transportation world a tendency to regard with favor the latest inventions in the line of machinery for the rapid unloading of iron ore, namely, the automatic unloaders which dispense entirely with human energy directly applied in the unloading operations. The fundamental principle of all the automatic unloaders is found in the operation of some sort of a clam-shell bucket which is let down into the hold of a vessel with its iron jaws extended and, closing them, retains in its grasp



BRIDGE TRAMWAYS FOR HANDLING ORE AND COAL. MENOMINEE DOCK AT ASHTABULA.

one or more tons of ore while it is lifted from the hold and run back to a stock pile or waiting railroad cars after the manner of the bucket of the bridge tramway. The original automatic unloader, introduced only two or three years ago and in active use to-day, weighs several hundred tons, and is equipped with a great mast to be lowered through the vessel hatch and from which depends a clam-shell bucket capable of holding ten tons of ore. The later patterns of unloaders, automatic in their action, are fitted with excavating buckets of only about one ton capacity, and which therefore permit of hoisting and transference by wire cable instead of necessitating the ponderous iron and steel structure required to support the mast and clam-shell in the original design.

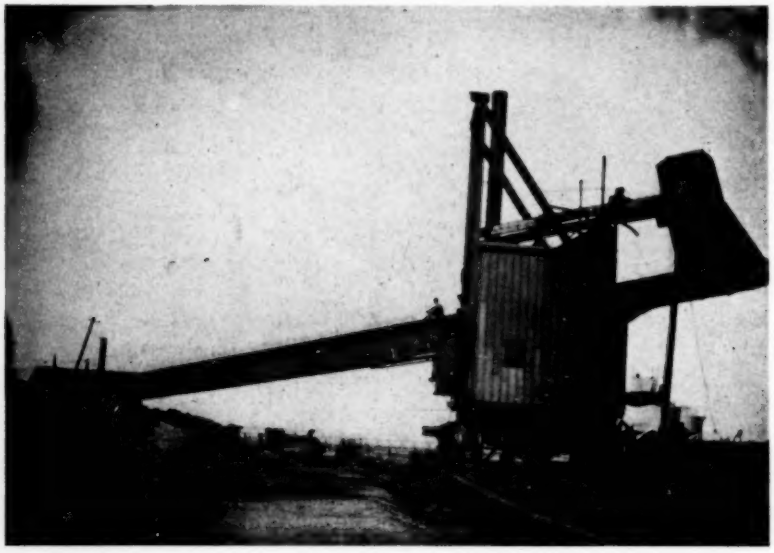
Bridge tramways similar to those in use on the ore-unloading docks are employed in the furnace yards to convey the ore from the railroad cars to stock piles, and a patent furnace hoist automatically conveys the ore together with the coke and limestone to the top of the blast furnace and performs the operation of 'charging.' The automatic hoist consists of an inclined iron-trussed bridge reaching from the floor of the stock house to the top of the furnace shell and from thence over the top opening of the furnace. On this bridge is laid a track of T rails on which travels a skip or car, containing the charge of one to three tons as may be desired. The track is so arranged at the top that the contents of the car are automatically dumped into the hopper on the arrival of the car at the top. The skip car is hoisted or hauled to the top by a double engine with a friction clutch drum.



CAR DUMPING MACHINE.

The exigencies of handling great quantities of coal for shipment have been quite as productive of ingenious mechanical devices as have the requirements of the iron industry. Bridge tramways have been employed extensively for both loading and unloading of fuel, and in the case of anthracite coal clam-shell buckets and bucket shovels which scoop up the coal have been introduced in connection with the bridge tramway instead of the ordinary bucket. However, preeminent among all the varied forms of coal-handling apparatus stands the car-dumper, a class of machine, each step in the evolution of which has been marked

by a distinct type of apparatus, but which has finally reached a point of development where it is possible for one of these machines to hoist a loaded coal car into position alongside a vessel, pour its contents into chutes communicating with the hold and return the empty car to the track in the elapsed time of one minute. In the case of the most approved styles of car-dumpers the loaded car is clamped to the track in a sort of cradle in such manner that it may be turned completely over and yet by means of a reciprocating movement on the part of a huge pan suspended in the framework of the machine and connected with the chute leading to the hold of the vessel, the coal is transferred with a minimum amount of breakage.

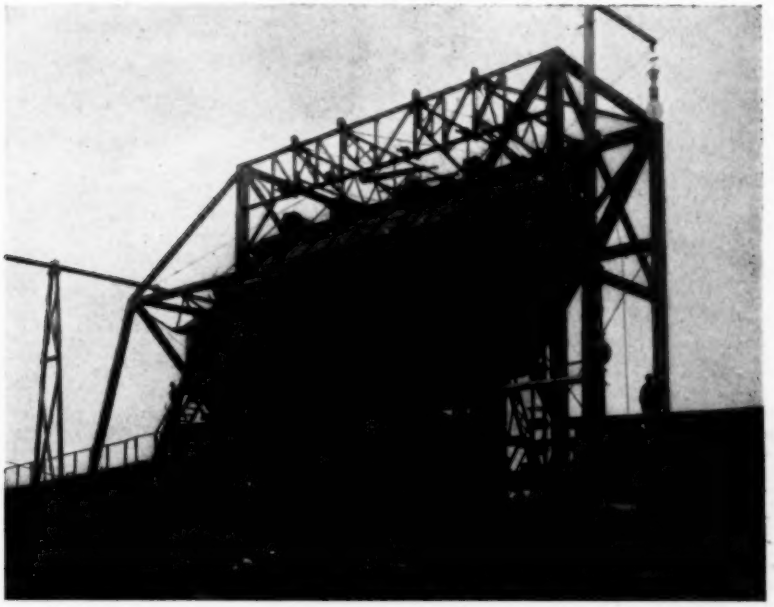


McMYLES CAR DUMP.

A class of coal-handling machinery in which recent years have witnessed great development is found in the various forms of chain elevators and link-belt machinery. This form of equipment is used extensively at railroad coaling stations designed to supply fuel to locomotives. In a representative installation one run of the upper conveyor is for stocking the coal and the other for distributing it into chutes, while the lower conveyor delivers coal from storage. Each conveyor is an endless chain interspersed with metal partitions forming pockets, is 600 feet in length and has a capacity of 120 tons of coal per hour. In many stations an inclined conveyor delivers coal from cars to a distributing conveyor and the latter apportions the fuel among twelve or more chutes. Conveyors of this same general type are

also used for transferring coal from mine to storage pile or cars. For such utilization there is selected apparatus of great simplicity of design, namely, a scraper conveyor with steel flights of proper shape attached to the chain and drawing the material along in a steel trough. Some installations of this character have a length of about 300 feet and a capacity of four tons of coal per minute.

Modifications of the belt conveyor are now to be found in use in almost every branch of the industrial domain, being put to a variety



CAR DUMPING MACHINE.

of uses ranging all the way from the movement of grain to the carriage of logs and stone. Moving platforms, constructed on the endless chain plan, also have an important place among the utilities for handling bulk commodities. Likewise is there extensive employment of traveling cableways and aerial ropeways wherein either the impetus of gravity or hauling ropes are depended upon for propulsive power. Some of the recently installed traveling cableways have a span exceeding 700 feet and are adapted for handling loads of from five to ten tons. The most modern of all of these aerial transportation systems is that designated 'telpherage,' whereby electricity is relied upon as an operative force. In this class of installations the overhead trolley system of the ordinary electric railway has simply been adapted to the rope railways, and by the provision of an ingenious device the electric car or telpher is enabled automatically to slacken speed when approaching a

curve, resuming the normal rate of travel when the dangerous point has been passed.

The part which cranes of various kinds have played in the solution of the problem of the economical handling of raw material of various kinds is indeed an important one and there has been a steady increase in capabilities until there are now in service in the United States a number of cranes each of which is capable of handling a load of one hundred tons.

Easily the most remarkable of all the cranes yet constructed are the great balanced cantilevers invented by Alexander Brown, an American. The cantilever crane is applicable to a large range of work and is the

CANTILEVER CRANE.

most perfect machine yet devised for use in handling armor plate and other heavy parts in ship-yards and manufacturing establishments generally. The cantilever is divided into two arms, which in some instances have a span of over 350 feet. By means of trolley and hoist block, mounted on the cantilever of the crane, the load can be hoisted from the ground and traversed from one end of the cantilever to the other, the pier or base of the crane being so arranged that the load passes through it. These cantilever cranes have an automatic counter-weight running on a track along the bridge and above the hoisting trolley, and connected by ropes to the latter, so that whatever the position of the hoisting trolley on one arm of the crane, the counter-

weight at all times automatically occupies a similar position on the other arm. The latitude of the operations of the apparatus is further broadened by reason of the fact that the entire crane travels by its own power up and down the track or trestle on which it is mounted. A crane of this type is capable of marvelous speed. A load of fourteen tons may be hoisted at a speed of 200 feet a minute; the trolley travels back and forth along the cantilever arms at a speed of 600 feet a minute; and the entire crane has sufficient propulsive power to enable a speed of 750 feet a minute in traversing the track or trestle.

In conclusion attention must be given to the so-called lifting magnet, the most wonderful of all the new appliances for handling weighty raw material. The electro-magnet, by the aid of electricity, performs on a large scale something of the same function as the toy with which children have long been familiar. One magnet will elevate a mass of metal weighing two tons and it is possible to use several magnets simultaneously in handling a particularly heavy steel plate or bar. This plan of handling material also possesses immense economic advantages, inasmuch as a single mechanic is usually in charge of the crane to which the magnets are attached.

MENTAL AND MORAL HEREDITY IN ROYALTY. IV.

By Dr. FREDERICK ADAMS WOODS,
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Evidence from Sweden.

Gustavus Vasa to Charles XIII.

THE houses of Vasa, Palatine and Holstein, which held the throne of Sweden from 1527 to 1818, give us the names of 48 related persons in the direct family and cover a period of eleven generations. By including the ancestors to the third degree for each generation of children, we bring in 122 more names, and have in this total of 170 an abundant and interesting field for the study of heredity. These families of Sweden are full of eccentricities, abilities and weaknesses, and the tracing of these peculiarities will be the subject of this section of the work.

Gustavus I. Vasa, 1496–1560, the founder of the celebrated dynasty bearing his name, was a most remarkable and inspiring character. Of a noble though poor and uninfluential family, young Gustavus gave proof even in youth of that striking personality which was destined to deliver Sweden from the terrors of misrule and foreign control, and make his name ever cherished in the hearts of his countrymen. Even as a boy he 'played the king' and declared he would live to drive the Danes out of Sweden.

In 1517 Gustavus was captured by a Danish ship of war and imprisoned for a year in castle Kalloe in North Jutland. Having escaped from prison, he fled to the mountains of Dalencaride, where, after enduring great hardships, he at last succeeded in attaching to himself a powerful party, with which he marched towards Stockholm, which finally surrendered in 1524 after an obstinate defense. The throne of Sweden was now offered to him, but he at first refused. At last, after general solicitation with the interest of the welfare of his country at heart, he accepted and was crowned king in June, 1527.

Born in a private station and bred in the school of adversity, equally great in the public characters of a legislator, warrior and politician, he distinguished himself in every station of life, whether we consider his cool intrepidity and political foresight, his talents for legislation, his propensity to letters and encouragement of learning, his affability to the lowest ranks and his solid and enlightened piety.

All his qualities set off by a majestic and graceful person and still further heightened by the most commanding eloquence, drew the esteem and admiration

of all, so that it might justly be said that the most arbitrary monarch never exercised a more unbounded sway over his vassals than Gustavus possessed from the voluntary affection of his free-born subjects. In a word he was a sovereign who was esteemed by foreigners no less than by his own people, by contemporaries as well as by posterity, one of the wisest and best that ever adorned a throne.*

We shall see later how closely he was reproduced in his grandson Gustavus Adolphus the Great.

The father of this founder of the house was Eric Johnson, who is described as an insignificant little man with a violent and uncontrollable temper.† The other ancestors are 'obscure' and, as far as known, were without special gifts of any sort. So Gustavus Vasa must be considered a new variation or a 'sport' in biological terminology. How this genius was transmitted we shall see in the subsequent history of the house.

Of the nine children available for our study, we have very complete accounts concerning five. These are Eric, John, Charles, Magnus and Cecelia. The others did not distinguish themselves in any way as far as known. Of these five, all but one, Charles, were violent or eccentric or both. The mother of all but Eric, Margaret Lejonhufond, was a gentle, beautiful and tactful princess‡ with whom Gustavus lived very happily. Therefore, since the grandfather, Eric, was violent and cruel, and since insanity appeared in Eric and Magnus, the children of both marriages of Gustavus, it seems fair to assume that the lack of mental balance was hereditary, and on the male side. Whatever may have been its origin, the neurosis was a family trait and eccentricities of one sort or another will be found in several of the descendants.

Eric, the eldest son and next king, was suspicious, gloomy and cruel; and finally becoming insane was obliged to abdicate.§ He was nevertheless extremely learned, having a profound acquaintance with the classics and all the sciences of his day, especially the occult branches.

John, the second son, was both passionate and weak.

His tender conscience, though it did not prevent him poisoning his father, Eric, yet induced him to pay a most scrupulous obedience to the ridiculous penance ordered by the pope for commission of the murder. His temper hasty, his disposition selfish, with strong instinctive attachments, so that in domestic life he oscillated between the extreme of indulgence and severity . . . he at last grew to be afraid of his own shadow.‖

Magnus became insane. Cecelia, his sister, brought disgrace on the family even in her youth. Later she went to England with her

* Coxe, 'Travels in Russia, Sweden and Denmark,' IV., 132–134.

† Geijer, 'History of Sweden,' I., 97.

‡ Geijer, I., 127.

§ Coxe, 'Travels,' IV., 126, and 'Ency. Brit.,' 8th ed.

‖ Coxe, *Op. cit.*, IV., 247.

husband, where she got frightfully into debt, and died after leading a rambling and dissolute life.*

Charles IX., by far the flower of the family, inherited much of the genius and character of his father.

Although the transcendent merits of Charles the Ninth are eclipsed by the superior qualities of his father and son, yet even as the son of Gustavus Vasa and father of Gustavus Adolphus he seems to shine no less with nature than reflected luster. He was enterprising yet cautious in war, sagacious and decisive in the cabinet, a friend to humanity, yet severe in punishment of crimes. Attached by principle to the Protestant cause, he raised it, almost drooping, again to preeminence. Zealous to promote the interest of his people, he built towns, encouraged commerce and agriculture and patronized letters. Of quick and lively feelings, he was subject to violent but short transports of passion, which harassed his frame and finally occasioned his death.†

Another type of Vasa eccentricity is found in the career of Gustavus, the son of the mad Eric XIV. Gustavus had from youth an adventurous and curious existence. Rescued when an infant from the sac in which he was to have been murdered, he was conveyed from Sweden to the Jesuit convents of Thorn and Vienna.

In these different seminaries he made considerable progress in literature and in particular distinguished himself in so much by his proficiency in chemistry that he was called the second Paracelsus. He was no less remarkable for his knowledge of languages, speaking with fluency, besides his native tongue, French, Italian, German, Polish, Russian and Latin. He was indeed so zealous in the prosecution of his studies, that on account of his indigent circumstances, after attending the schools by day, he used in the evening to play at the inns in the lowest capacity, in order to procure a scanty subsistence.

His literary acquisitions, however, did not advance his future, for he passed a wandering life in the greatest misery; was reduced to such straits that he frequently had recourse to charity and at other times earned his living by the meanest occupations.‡

Here we see a striking instance of a son resembling his father. The literary and scientific one-sidedness so strongly marked appears with equal force even under these trying and humble circumstances, and when no influence of family example could have taken a share in its formation, since Gustavus when an infant was removed from the surroundings in which he was born.

Sigismond III., 1566–1632, the next to be considered, was also in his way a rather unusual character, though the figures 4.5 do not indicate it. This son of the brother, John, and of Catherine, daughter of Sigismond I. of Poland, acquired the throne of Sweden before his uncle, Charles IX. The bigotry of Sigismond, combined with his weakness and peevishness, led to discords and estranged his subjects from

* W. B. Rye, 'England as seen by Foreigners,' 1865, introduction.

† Coxe, V., 175.

‡ Coxe, 'Travels in Russia, Sweden, Denmark,' IV., 251.

him, so that his uncle, Charles, was gladly welcomed as a deliverance to the country, and Sigismond was formally deposed in 1604.

It should be noticed that of all the children of the illustrious Gustavus Vasa, Charles IX. was by far the best, and it was the son of this king who became the brightest light in Swedish history, probably everything considered, the greatest figure in all modern royalty, and one of the most ideal heroes who ever lived, Gustavus Adolphus the Great.

To recount the characteristics of this celebrated champion of the Protestant cause would be but to repeat again the eulogies for the founder of the house, his grandfather. The nobility and genius of Gustavus Adolphus are too well known to need much comment here. It will be sufficient to quote a few extracts from the many works devoted to his life and achievements.

> He ascended to the throne in his seventeenth year and soon gave proof of his extraordinary abilities. The military talents of Gustavus Adolphus were of the highest order, but they were surpassed by his admirable qualities as a man and his virtues as a ruler.* Gustavus was, says Schiller, incontestably the first commander of his century and the bravest soldier in the army which he created. His eye watched over the morals of the soldiers as strictly as over their bravery. In everything their lawgiver was also their example. In the intoxication of his fortune he was still a man and a Christian, and in his devotion still a hero and a king.

Such is the universal testimony of both contemporaries and historians in admiration of the sublime personality of Gustavus Adolphus, the Lion of the North, who like a brilliant comet flashed for a brief time over European affairs, until his course was terminated all too soon while defending the faith for which he gave his life.

Cut off in his thirty-eighth year, when most men are only beginning to assume the full responsibilities for which they are fitted, we do not know what might have been the limit to the manifold acts of benefit and righteousness that would have been conferred by Sweden's greatest king. Let us pause in passing to consider the mysteries of fate that heaped upon this man, sandwiched in between the maniacs and weaklings of his family, all the gifts of mind and heart ever allotted to mortals. If great men are divine, then heredity is, for Gustavus Adolphus is but a perfect repetition of his illustrious grandfather.

After the death of the great king, Sweden passed into the hands of a regency for Christina, his only child. Her sprightly wit and spirit, her energy and taste for learning, all gave her countrymen the greatest hope for a brilliant future for their beloved little queen 'who astonished her guardians by the vigor of her understanding.' In 1644 on her eighteenth birthday, she assumed supreme power and for some

* Lippincott's 'Biog. Dict.'

time fulfilled all the expectations which had been formed for her reign.

The Swedish people were anxious that Christina should marry, but she declined to sacrifice her independence. In 1649, however, she persuaded the Diet to accept as her successor the best of her suitors, Charles Gustavus of Palatine-Deux-Ponts, the son of the only sister of Gustavus Adolphus. In the following year she was crowned with great pomp.

About this time Christina's character seemed to undergo a remarkable change. She became wayward and restless, neglected her tried counsellors, and followed the advice of self-seeking favorites. So much discontent was aroused by her extravagance and fickleness that she at last announced her determination to abdicate.*

After abdication in 1654 she left for foreign courts, where her eccentricities and daring disregard for conventionalities became the talk of Europe. Upon the whole her character presents a strange combination of faults and foibles, pushed to the most extravagant excess. She says of herself, 'that she was mistrustful, ambitious, passionate, haughty, impatient, contemptuous, satirical, incredulous, undevout, of an ardent and violent temper and extremely amorous.'

The violent temper was common to a large number of her paternal ancestors, but it is especially interesting to note that the change in her character was very similar to that of her uncle, Eric XIV., who began his reign very well, and whose unstable temper did not display itself until he was about twenty-five years old.† Magnus, his brother, likewise became insane at just about the same age. The inconsistencies of character which stand out so strongly in many of the members of this family have not been very common among royalty. They were found to be very common among the relations of Peter the Great, where they were considered related to a family neurosis. Here there is also a neurosis, so we have in the coincidence a very strong proof that much of the *moral* nature here inherited in the form of inconsistencies, as well as the mental, is subject to heredity.

Since Christina abdicated to her cousin, Charles Gustavus, we now take up the Palatine Deux-Pont dynasty of Sweden, which includes the characters numbered from 19 to 27 inclusive.

Charles Gustavus, it is to be remembered, was the best of the many suitors for the hand of the eccentric Christina, and although he, like all the others, failed to change her mind regarding her determination to remain single, her appreciation and regard for him were such that she succeeded in having the succession made in his name. The father to this new heir to the throne was likewise a man of excellent charac-

* 'Ency. Brit.,' 9th ed., art. Sweden.

† Cont. Geijer 'Hist. Sweden,' I., 148.

ter, energy and abilities. Besides, we find Wolfgang of Palatine, 1569, the great grandfather, a man of great distinction in his day. As Catherine, the mother of Charles and sister of the great Gustavus Adolphus, was intellectual and energetic, we have here in starting the new dynasty a selection of by far the better members of the family.

Charles X., himself, was a rather remarkable character, being a man of the greatest enterprise and, as a commander, showed the family brilliancy in a striking degree. His measures were in general entirely just, his only noteworthy weakness being his passionate temper.*

The only child of Charles X. was Charles XI., who became king of Sweden in his turn and began to exercise his power in 1692. He seems to repeat the character of his father almost exactly.

> Charles was chaste, temperate, economical, vigilant and active, a patron of letters, severe yet not implacable, prone to anger but easily softened. If we consider the interior administration of affairs, Charles XI. was one of the wisest monarchs who ever sat upon the throne of this kingdom. To him Sweden stands indebted for many excellent regulations which still subsist.† He promoted manufacture, commerce, science and arts, subverted the power of the senate, and when he died, left a flourishing kingdom to his son Charles XII.‡ He died aged forty-two, lamenting, it is said, upon his death bed, as the only reproach to his memory, the natural violence of his temper, which he had not sufficiently corrected.§

Charles XI. married Ulrica Eleonora, a virtuous and intellectual princess. She was a daughter of Frederick III. of Denmark, and sole representative among six children of that little group of brighter lights forming Denmark's highest intellectual wave, and centered about Christian IV., her greatest king.

From this union sprang two daughters, in no way remarkable, beside one son, born in 1682, who, as Voltaire says, 'became as Charles XII. perhaps the most remarkable man who ever existed upon this earth, who united in himself all the great qualities of his ancestors, and who had no fault or misfortune except in having them too greatly exaggerated.' Invincibly obstinate from childhood, the only way of moving his will was through his sense of honor. Charles was inordinately ambitious from youth, his only desire being to imitate the career of Alexander the Great. When only eighteen years old an opportunity was given him to display his 'extraordinary martial genius' in his unequal contest against three of the most powerful monarchs in Europe. Peter the Great, of Russia; Frederick IV., of Denmark, and Augustus, King of Poland, thinking on account of the youth of Charles to divide his kingdom between them, formed a league against

* Coxe, 'Travels,' IV., 34. 'Ency. Brit.' 9th ed.

† Coxe, 'Travels, IV., 39.

‡ Lippincott's 'Biog. Dict.'

§ Schloetzer's 'Briefwechsel,' I., 147.

him. With only 20,000 Swedes he attacked 80,000 Russians under the Czar Peter who were besieging Narva and then, with only 8,000 men, before the arrival of his main army, gave the Russians such a severe defeat that they were filled with consternation.* A little later when Peter made overtures for peace he replied that he would 'treat with the Czar at Moscow.'

Charles was by no means successful in his subsequent battles, but considering the enormous odds against him, this demibarbarian 'whose ambition was madness and whose valor was ferocity' may justly be considered one of the greatest commanders of modern times, as well as one of the most remarkable men who ever lived. Rude, but chaste, frugal in his dress, food and mode of living, he seems to have had few failings save his impetuosity and inordinate ambition.

Of course such a character as Charles can never be directly derived from any law of heredity like Galton's. A man who has more of certain characteristics than other men can not be produced by adding together in a proportionate way the same characteristics of his ancestors. But if these extreme types like Charles, Peter the Great, Don Carlos, son of Philip II., and Frederick the Great occur most frequently where there is much of the same sort of character in several of the ancestors, we are better satisfied that the types are the product of hereditary influence, than if they frequently occurred in regions where none of the relatives show the character in question. The wave does not flow back towards the mean for every child or even for every generation. It also flows in an upward swell, and it is only to be expected that variations shall occur that show its highest manifestation where there is already some considerable indication of its presence in the neighborhood of the person in whom it appears in such an extreme degree.

In referring back to the ancestry we find the character of Charles XII. almost exactly repeated, though in a lesser degree, in both his father and grandfather. They were both active, vigilant, enterprising and warlike, frugal in daily living, but passionate in their temper. There were ambitions or marked talents in nearly all the other ancestors. His mother was intellectual and virtuous and derived as we have seen from the most able region of Denmark. So, after all, taking into consideration the two sisters of Charles XII., who were nobodies in the intellectual scale, we do not find this fraternity to which he belongs giving us more than is called for.

We are now brought to the dynasty of Holstein, which in the six characters, numbered from 28 to 33 inclusive, gives us no names that amount to anything; nor am I able to find out anything concerning the apparent nonentities who formed the ancestry and relationship of

* Lippincott's.

these. With the exception of Charles Frederick of Holstein, also an inferior character, this new dynasty is in no way related to the former dynasty of Palatine, which, like that of Vasa, we have found so remarkable.

Adolphus Frederick of Holstein, one of the inferior ones above mentioned, married Louisa Ulrica, a sister of Frederick the Great. We find in her a woman of a very different stamp. Among all the richly endowed sisters of Frederick the Great, Louisa Ulrica, Queen of Sweden, stands probably at the head of the list. An idea of her character and attainments can be drawn from several contemporaries here quoted.

> The Queen Dowager to whom we had the honor of being presented, a sister of the King of Prussia . . . a princess who resembled her brother as well in the features of her countenance as in those eminent qualities which characterize the house of Brandenburg.
>
> She was accustomed to rule the cabinet with absolute authority in the reign of her husband.*
>
> A great and inflexible woman of rare endowment and uncommon cultivation. Really merited the appellation of the 'Minerva of the North.'

Since Louisa Ulrica belongs, of course, among the Hohenzollerns, we have passed rather rapidly over the dynasty of Holstein, which to this point has furnished no great names. The next generation, children of Adolphus Frederick and Louisa Ulrica, gives us four, and among them, third in the list, Gustavus Adolphus III., who was destined to shine as another Swedish king of extraordinary ability.

> His ardent mind and fertile genius acted as a perpetual impetus to things that were new, grand and out of the common track. He was so accomplished a gentlemen that there was scarcely a professor of literature or any of the liberal arts but he was able to excel each in his own peculiar study. He was always spoken of as a prodigy of talents.†

Lippincott's 'Biographical Dictionary' says that

> In addition to his talents as a statesman, he was distinguished as a poet and dramatist.

This literary bent was very strong in his mother as well as in many members of her family.

His sister, Sophia Albertina, 'was possessed of a great share of personal virtue and a capacity as vast and varied as her brother, and unsullied by his vices.' The oldest brother amounted to nothing, while the youngest, as Charles XIII., showed in his ambition, wisdom and skill in the management of the country's affairs much of the family genius.

Gustavus IV., the only son of Gustavus III. and the last of the

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* Coxe, 'Travels,' IV., 30.

† J. Brown, 'Northern Courts.'

family, though gifted to a certain extent, carried ambition to madness and folly, and being finally deposed, supported himself by writing, together with a small pension. Since Charles XIII., the uncle of Gustavus IV. who succeeded him on the throne, adopted and made successor, Bernadotte, Napoleon's agent, we have now reached the close of our chapter on modern Sweden.

In the study of this country, from Gustavus Vasa to Gustavus III. Adolphus, we find throughout a most perfect confirmation of the theory of mental and moral heredity. We find that in selecting those who were to become the progenitors of the next generation, twice a choice of the best among them all in Charles IX. and Charles X., and the cause of this selection lay in the fact that their very merits brought to them the throne. In the union of Charles the Tenth's great son with the strongest part of Denmark's dynasty, we have still another point where the genius was not allowed to die. We find no more great names, only the petty Holsteins, until Gustavus III. Adolphus reclaims once more the glory of his ancestors, but this we find to be not the ancient genius but a fresh graft, and from the famous Hohenzollerns taken at the height of their intellectual eminence in the time of Frederick the Great.

In all this Swedish history the lives of these men and women can not be explained by environment. If we adopt this view, why did so many among them who must have had most abundant opportunities, fail entirely to exhibit any of these remarkable mental statures? The only serious failing on the moral side was their violent and ungovernable temper. Since there was also mental unbalance in the family, it seems fair to assume that these violent tempers were a manifestation of the neurosis, and not to be ascribed to their high and arbitrary position.

Also, relative to the moral qualities in this family, there does not seem to be any good reason from the standpoint of environment, why there should be such an absence of that dissolute and licentious type so continually found in Spain, France and Russia during these same centuries. But if we look at it from the standpoint of heredity, we can easily see why this is so, since it was neither there to any great extent in the earlier generations, nor was it in those who became the subsequent ancestors of the different male lines considered. It does not seem as if the example set to princes by their parents should be of more effect than general temptations such as come to all who have abundant means at their disposal; and we know too many examples both in royalty and out, where parental influence has sadly failed to inculcate such desirable lessons.

HOW TO COLLECT FISHES.

By President DAVID STARR JORDAN,
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IN the collection of fishes, three things are vitally necessary—a keen eye, some skill in adapting means to ends, and some willingness to take pains in the preservation of material.

In coming into a new district the collector should try to preserve the first specimen of every species he sees. It may not come up again. He should watch carefully for specimens which look just a little different from their fellows, especially for those which are duller, less striking or with lower fins. Many species have remained unnoticed through generations of collectors who have chosen the handsomest or most ornate specimens. In some groups, with striking peculiarities, as the Trunk-fishes and Porcupine-fishes, practically all the species were known to the predecessors of Linnæus. No collector could pass them by. On the other hand, new gobies or blennies can be picked up almost every day in the lesser known parts of the world. For these overlooked forms, herrings, anchovies, sculpins, blennies, gobies, scorpion-fishes, the competent collector should be always on the watch. If any specimen looks different from the rest, take it at once and find out the reason why.

In most regions, the chief dependence of the collector is on the markets, and these should be watched most critically. By paying a little more for unusual, neglected or useless fish, the supply of these will rise to the demand. The word passed along among the people of Onomichi, in Japan, that 'Ebisu the fish-god was in the village' and would pay more for Okose (poison Scorpion-fishes) and Umiuma (Sea-horses) than real fishes were worth soon brought (in 1900) all sorts of Okose and Umiuma into the market when they were formerly left neglected on the beach. Thus with a little ingenuity the markets in any country can be greatly extended.

The collector can, if he thinks best, use all kinds of fishing tackle for himself, hooks, flies, bait; seines, traps, anything that will catch fishes. In Japan he can use the 'dabonawa' long lines, and secure the fishes which were otherwise dredged by the *Challenger* and *Albatross*. If dredges or trawls are at his hand he can hire them and use them for scientific purposes. He should neglect no kind of bottom, no conditions of fish life which he can reach. Especially important is the

fauna of the tide-pools, neglected by almost all collectors. As the tide goes down, especially on rocky capes which project into the sea, myriads of little fishes will remain in the rock-pools, the algæ and the clefts of rock. In regions like California, where the rocks are buried with kelp, blennies will lie in the kelp as quiescent as the branches of the algæ themselves until the flow of water returns.

A sharp, three-tined fork will help in spearing them. The water in pools can be poisoned on the coast of Mexico, with the milky juice of the 'Hava' tree, a tree which yields strychnine. In default of this, pools can be poisoned by chloride of lime, sulphate of copper, or, if small enough, by formaline. Of these, a solution of commercial chloride of lime, yielding free chlorine gas is cheapest and most serviceable. By such means the contents of the pool can be secured and the next tide carries away the poison. The water in pools can be bailed out, or better emptied by a siphon made of small garden hose or rubber tubing. On rocky shores and about coral reefs dynamite can be used to very great advantage, if the collector or his assistant dare risk it, and if the laws of the country do not prevent. Most effective in rock-pool work is the help of the small boy. In all lands the collector will do well to take him into his pay and confidence. Of the hundred or more new species of rock-pool fishes lately secured by the writer in Japan, fully two thirds were obtained by the Japanese boys. Equally effective is the 'muchacho' on the coasts of Mexico.

Masses of coral, sponges, tunicates and other porous or hollow organisms often contain small fishes and should be carefully examined. On the coral reefs the breaking up of large masses is often most remunerative. The importance of securing the young of pelagic fishes cannot be too strongly emphasized.

Fishes must be permanently preserved in alcohol. Dried skins are far from satisfactory, except as a choice of difficulties in the case of large species. Dr. Gunther thus describes the process of skinning fishes:

> Scaly fishes are skinned thus: with a strong pair of scissors an incision is made along the median line of the abdomen from the foremost part of the throat, passing on one side of the base of the ventral and anal fins, to the root of the caudal fin, the cut being continued upwards to the back of the tail close to the base of the caudal. The skin of one side of the fish is then severed with the scalpel from the underlying muscles to the median line of the back; the bones which support the dorsal and caudal are cut through, so that these fins remain attached to the skin. The removal of the skin of the opposite side is easy. More difficult is the preparation of the head and scapulary region; the two halves of the scapular arch which have been severed from each other by the first incision are pressed towards the right and left, and the spine is severed behind the head, so that now only the head and shoulder bones remain attached to the skin. These parts have to be cleaned from the inside, all soft parts, the branchial and hyoid apparatus, and all smaller bones being cut away

with the scissors or scraped off with the scalpel. In many fishes which are provided with a characteristic dental apparatus in the pharynx (Labroids, Cyprinoids), the pharyngeal bones ought to be preserved, and tied with a thread to their specimen. The skin being now prepared so far, its entire inner surface as well as the inner side of the head are rubbed with arsenical soap; cotton-wool or some other soft material is inserted into any cavities or hollows, and finally a thin layer of the same material is placed between the two flaps of the skin. The specimen is then dried under a slight weight to keep it from shrinking.

The scales of some fishes, as for instance of many kinds of herrings, are so delicate and deciduous that the mere handling causes them to rub off easily. Such fishes may be covered with thin paper (tissue paper is the best) which is allowed to dry on them before skinning. There is no need for removing the paper before the specimen has reached its destination.

Scaleless fishes, as siluroids and sturgeons, are skinned in the same manner, but the skin can be rolled up over the head; such skins can also be preserved in spirits, in which case the traveller may save himself the trouble of cleaning the head.

In the field it is much better to use formalin (formaldehyde) in preference to alcohol. This is an antiseptic fluid dissolved in water, and it at once arrests decay, leaving the specimen as though preserved in water. If left too long in formalin fishes swell, the bones are softened and the specimens become brittle or even worthless. But for ordinary purposes (except use as skeleton) no harm arises from two or three months' saturation in formalin. The commercial formalin can be mixed with about 20 parts of water. On the whole it is better to have the solution too weak rather than too strong. Too much formalin makes the specimens stiff, swollen and intractable, besides too soon destroying the color. Formalin, has the advantage, in collecting, of cheapness and of ease in transportation, as a single small bottle will make a large amount of the fluid. The specimens also require much less attention. An incision should be made in the right side of the abdomen to let in the fluid. The specimen can then be placed in formalin. When saturated, in the course of the day, it can be wrapped in a cloth, packed in an empty petroleum can and at once shipped. The wide use of petroleum in all parts of the world is a great boon to the naturalist. Before preservation, the fishes should be washed, to remove slime and dirt. They should have an incision to let the fluid into the body cavity and an injection with a syringe is a useful help to saturation, especially with large fishes. Even decaying fishes can be saved with formalin.

The collector should mark localities most carefully, with tin-tags and notebook records, if possible. He should, so far as possible, keep records of life colors, and water color sketches are of great assistance in this matter. In spirits or formalin, the life colors soon fade, although the pattern of marking is usually preserved or at least indi-

cated. A mixture of formalin and alcohol is favorable to the preservation of markings. In the museum all specimens should be removed at once from formalin to alcohol. No substitute for alcohol as a permanent preservative has been found. The spirits derived from wine, grain, or sugar is much preferable to the poisonous methyl or wood-alcohol.

In placing specimens directly in alcohol, care should be taken not to crowd them too much. The fish yields water which dilutes the spirit. For the same reason, spirits too dilute are ineffective. On the other hand, delicates fishes put into very strong alcohol are likely to shrivel, a condition which may prevent an accurate study of their fins or other structures. It is usually necessary to change a fish from the first alcohol used as a bath into stronger alcohol in the course of a few days, the time depending on the closeness with which fishes are packed. In the tropics, fishes in alcohol often require attention within a few hours. In formalin, there is much less difficulty with tropical fishes.

Fishes intended for skeletons should never be placed in formalin. A softening of the bones which prevents future exact studies of the bones is sure to take place. Generally alcohol or other spirits, arrack, brandy, cognac, rum, sake, 'vino' can be tested with a match. If sufficiently concentrated to be ignited, they can be safely used for preservation of fishes. The best test is that of the hydrometer. Spirits for permanent use should show on the hydrometer 40 to 60 above proof. Decaying specimens show it by color and smell, and the collector should be alive to their condition. One rotting fish may endanger many others. With alcohol it is necessary to take especial pains to ensure immediate saturation. Deep cuts should be made into the muscles of large fishes as well as into the body cavity. Sometimes a small distilling apparatus is useful to redistil impure or dilute alcohol. The use of formalin avoids this necessity. Small fishes should not be packed with large ones; small bottles are very desirable for their preservation. All spinous or scaly fishes should be so wrapped in cotton muslin as to prevent all friction.

The methods of treating individual groups of fishes and of handling them under different climate and other conditions are matters to be learned by experience. Eternal vigilance is the price of a good collection as it is said to be of some other good things. Mechanical collecting, picking up the thing got without effort and putting it in alcohol without further thought, rarely serves any useful end in science. The best collectors are usually the best naturalists. The collections made by the men who are to study them and who are competent to do so are the ones which most help the progress of ichthyology. The student of a group of fishes misses half the collection teaches if he has made no part of it himself.

SCIENTIFIC LITERATURE.

PSYCHOLOGY OF RELIGION.

'THE Varieties of Religious Experience' is the interesting title of Professor William James's most recent volume, 'being the Gifford Lectures on Natural Religion delivered at Edinburgh in 1901–1902.' It is 'a study in human nature,' a contribution to the empirical psychology of man's religious constitution, and as such marks an innovation in the course pursued by Gifford lecturers, who had previously concerned themselves with the philosophy of religion or its history objectively considered. It was a happy thought which set Professor James the difficult and delicate task of analyzing the subjective phenomena of the religious life—or, rather, of religious lives.

In the attempt to classify types of religious experience, the author has laid under extensive contribution autobiographical documents which represent all manner of sects in and out of Christendom. The chapters abound in quotations from the extravagant deliverances of these souls, selected to emphasize the several tendencies in an extreme form.

The scope of the book may be suggested by the titles of some of the chapters: 'Religion and Neurology,' 'The Reality of the Unseen,' 'The Religion of Healthy Mindedness,' 'The Sick Soul,' 'The Divided Self and the Process of its Unification,' 'Conversion,' 'Saintliness,' 'Mysticism,' 'Philosophy,' etc.

While this book is principally occupied with a descriptive account of religious experiences, and a sharp line is drawn between description and valuation, a critical estimate of each type is attempted. Herein the author's wide sympathies come into play, with a capacity for appreciation extreme almost to a fault. Not by its origin, but by its 'fruits for life,' shall a religion be judged, says Professor James, in accordance with his philosophical pragmatism. And the complexity of life provides for the utility of diverse types. The very 'variety' is esteemed significant of possible ranges of unexplored experience. This falls into line with Professor James's individualistic or pluralistic attitude toward the universe, and brings us to the characteristic philosophical considerations which are merely hinted at toward the end of the volume, but which it is intended to marshal systematically in a later work.

Professor James confesses to a leaning toward a vague supernaturalism which he himself characterizes as 'crass,' and which is queer to say the least. It may be said to rest upon the conception of a 'subliminal' region of consciousness, not yet generally admitted into scientific psychology, but which is regarded by Professor James as the more significant part of our human nature, whereby we come into deepest relation with the universe.

No thoughtful reader, least of all a psychologist, can fail to profit by the immense suggestiveness of these lectures, which reveal afresh that psychological insight long since recognized as genius, while they are written in that no less brilliant style so familiar to Professor James's readers for a felicity of phrase unequaled in scientific literature. If one misses something of the scientific vigor of the 'Principles of Psychology,' one finds in compensation much of the mellow wisdom which has marked all of Professor James's later writings.

ONE of the most remarkable religious movements of the nineteenth century was that inaugurated by Joseph Smith, Jr., from 1820 to 1830. The announcement of the finding of a set of golden plates hidden in a hill in New York state and revealed to the prophet of the Almighty; said plates when interpreted by the prophet proving to be the history of the lost ten tribes of Israel, their journeying to America, their identification with the Indians, their further trials and tribulations, and their ultimate salvation and reconstruction in the Church of the Latter Day Saints,—this is indeed a sufficiently fantastic story. Mr. I. W. Riley devotes a volume (Dodd, Mead & Co.) to an analysis of the character of the founder of this sect. His interest is not in what the man did and the ultimate consequences of his establishment of a peculiar sect, but in the motives and impulses that led to the doing of it and to its successful propagandum. The study is psychological; and in the abnormal mentality of the founder Mr. Riley finds the clue to his actions. The tale is by no means complete, but the author has been most diligent in his search; and circumstantial evidence and arguments by analogy reach a high degree of probability. As a young man, Smith gave evidence of epileptic attacks; he was given to visions and was absorbed in crass forms of religious devotion; the 'Book of Mormons' was dictated while the author was in a semi-hypnotic condition self-induced, and directing his thoughts to the conviction of his own inspiration; his first converts were themselves credulous and suggestible, and the testimony of the witnesses to the vision of the plates was probably the result of a hypnotic suggestion. In brief, a study of abnormal psychological states convinces the author that Joseph Smith was a neurotic degenerate, with an ancestry of like temperament, and that his revelations were the riotous imaginings of his automatic imagination, exhibiting the kind of shrewdness and adaptation to existing conditions often to be found in mental products of such origin. The cumulative evidence for this view can be appreciated only by a direct reading of the book; it forms an interesting example of the application of modern psychological conceptions to the comprehension of a most unusual factor in the religious history of this country.

THE PROGRESS OF SCIENCE.

THE CARNEGIE INSTITUTION.

SCIENTIFIC interest this month is focused on the approaching meeting of the trustees of the Carnegie Institution. At the first meeting of the trustees, officers and an executive committee were appointed, and adjournment was taken to November without any decision on matters of policy. During the summer reports have been prepared by advisory committees of scientific men, and the secretary and other members of the executive committee have been engaged in careful consideration of the methods by which the Carnegie Institution can most effectively contribute to the advancement of science. The president of the institution has been abroad in consultation with foreign men of science and studying their institutions. The advisory committees have been selected with care, and it is doubtless proper that their reports should be regarded as confidential until they have been presented to the trustees. Scientific men would, however, be better pleased if the nomination of the members of the advisory committees had been entrusted to the scientific societies of the country and if they were sure that the trustees would take no action involving the institution in a definite policy until the questions at issue have been more thoroughly discussed. It would not be possible to select more representative trustees than those of the Carnegie Institution, but they are men of affairs, engaged in the conduct of important enterprises, and can not be expected to devote their attention to the policy of the institution. The plan which obtains in this country of entrusting the ownership and control of educational and scientific institutions to a board of business men, who appoint a president with great power, provides an efficient administration. It is not, however, ideal from the point of view of the scientific man—so long as he is an employee or slave he may do his work satisfactorily and economically, but he naturally looks forward to becoming a free man. We all know the difficulties and dangers of a democracy, but we have decided that this is for us the best form of government. Perhaps the greatest service that the Carnegie Institution could perform for science would be to entrust scientific men with its management. They would doubtless make mistakes and perhaps fall into quarrels, but in the end their education would be attained, and thereafter they would be more competent to manage their own affairs than any board of business men placed in authority over them.

As was stated in the September issue of the MONTHLY, the corporation of the Marine Biological Laboratory has voted to transfer its property to the Carnegie Institution; and this is the only intimation that has been made public in regard to the probable policy of the institution. But while the institution has secured an option on the laboratory, it is by no means certain that it will undertake the ownership. It has been announced by the chairman of the executive committee of the trustees of the laboratory that this will only be done after careful consideration and full discussion, and there is reason to believe that the Carnegie Institution may assist the laboratory without insisting on its becoming a branch or department. This question

opens the main problem before the institution, namely, whether it shall conduct several great laboratories for research or shall cooperate with existing institutions. There is doubtless much to be said on both sides. It appears from a series of articles by leading scientific men, published in recent issues of SCIENCE, that opinion is pretty equally divided. Some hold that the resources of the institution can be best utilized in the establishment of laboratories at Washington or elsewhere, while others think that for the present at least assistance should be given where it appears to be most needed. There is in either case some danger of too great centralization of power and of interference with individual initiative, and with agencies supported or likely to be supported from other sources. As a labor saving invention may at first disorganize a trade, though in the end for the benefit of society, so the great resources of the Carnegie Institution must be used with discretion if there is not to be a temporary inhibition of other agencies.

When compared with any similar agency, the funds of the Carnegie Institution are bewilderingly large. Thus in his presidential address before the British Association, Professor Dewar stated that the Carnegie Institution will dispose in a year of as much money as the members of the Royal Institution have expended in a century on its purely scientific work. The other institution most like that endowed by Mr. Carnegie is the Smithsonian, whose endowment was about equal to the annual income of the Carnegie Institution. Compared, however, with certain other agencies, for example, the U. S. Geological Survey, with its appropriation of $1,300,000, the funds of the Carnegie Institution are limited, and it is evident that they must be used economically, without any attempt to rival the government or universities, but doing what can be done only by an institution so unique in its possibilities.

THE COLLEGE AND THE UNIVERSITY.

THE first report of President Butler to the trustees of Columbia University exhibits the benefit of a university president's being from the outset a student of educational problems. The domestic economy of the university is reviewed in a masterly fashion, and questions of wide-reaching importance for the development of the educational institutions of the country are discussed by an acknowledged leader. The most pressing problem is the relation of the college to the university, and here President Butler outlines a policy which while radical appears to be in the line of advance. The plan of Harvard, Johns Hopkins and to a certain extent of Columbia has been to require a college degree for entrance to the professional schools. Students now enter the freshman class of these universities at the age of eighteen or nineteen. If they follow a four years' course at college and a three or four years' course in the professional school, they are on the average twenty-five years of age before they begin actual work with a period of apprenticeship before them. This is wrong both economically and educationally. Only the sons of the rich, who accept parental support when they should themselves be heads of families, are able to enter professional careers. The actual practice essential to professional work is postponed until the age of plasticity is passed.

President Eliot has long advocated a college course of three years, making it at the same time elective, so that a certain amount of work preparatory to the professions can be done at college. Columbia University admits seniors to its schools of medicine and law, permitting them to count part of their professional work toward the bachelor's degree. President Butler now advo-

cates admitting students to the professional schools at the close of the sophomore year, either giving them the degree of A.B. then or after a certain amount of professional work. The newspapers have raised an outcry over this suggestion—they declaim against debasing the bachelor's degree, attracting students by low requirements and the like, confusing the question of the degree as a mere counter with the educational problem. Thirty or forty years ago the A.B. degree did not represent more than the equivalent of the completion of the present sophomore year. It signified rather less than completion of the course of the German gymnasium, of the French lycée or of the English and Scottish universities. Unwise competition for the best students has raised, not lowered, the requirements for the A.B. and for entrance to the professional schools. The A.B. might be abandoned, as in Germany, without any particular loss to the educational system. Its meaning is now vague and unsatisfactory. The real question is: Shall we require students who have completed the high school course to spend four years on so-called liberal studies and athletics before they may begin their real work? This question must be answered in the negative and has been so answered by the logic of events. It is far better to make the professional schools more liberal—that is, more insistent on methods, general principles and research than on mere technique—rather than to require the A.B. degree as a preliminary. A more natural division of studies has been developed in France and Germany than here. The preparatory school and high school should be developed to include all studies that are required and pursued by text-books and recitations. The small denominational college should be placed on the level of the high school, where it can do good work. High schools and colleges should be found in every community. The universities can also conduct colleges for those who wish to go forward to the professional schools and faculties of philosophy or science. The student of the professional school who must complete his work in three years should be permitted to do so, while those who show ability for investigation and independent thought should work both in the professional school and the graduate school, and should be permitted to prepare simultaneously for the professional qualification and for the degree of A.M. or Ph.D., or what they represent.

THE BRITISH ASSOCIATION AT BELFAST.

THE seventy-second annual meeting of the British Association will not have the same historical significance as the famous meeting held in Belfast in 1874. At that meeting Tyndall delivered the address which was so widely criticized and discussed. It will be remembered by many that Tyndall there went beyond the limits of science and discussed problems of philosophy and religion. While his remarks were frank and outspoken, it is somewhat difficult for us to realize the objection taken to them thirty years ago. Scientific freedom has since been attained; and this to a certain extent may be said to date from Tyndall's address at the Belfast meeting of the Association. Professor Dewar's address at the present meeting was more nearly what is expected of such an address. After an introduction reviewing scientific organization and the place of Great Britain in science, he described those problems of chemistry on which he is the greatest living authority, namely, the history of cold and the absolute zero; the liquefaction of gases, especially hydrogen and helium; and various low temperature researches.

At the meeting of the sections a great number of important papers were presented, there being, however, an in-

creasing tendency for these to be technical rather than popular in character, as is also the case in our own national association. There is printed above the address by Professor Halliburton on physiology, and we hope to be able to publish subsequently the address by Professor Armstrong before the Section of Education, these being perhaps the two most interesting of the presidential addresses. In the physical section papers were presented by Lord Kelvin and Lord Rayleigh, perhaps the two greatest physicists now living. Lord Rayleigh discussed the question as to whether motion through the ether causes double refraction of light, reviewing the evidence which has led physicists to conclude that the earth in its motion does not drag the ether with it. Lord Rayleigh's experiments have confirmed those of our American physicists, Michelson and Morley, which showed that light travels through a body traversed by a stream of ether with the same speed along it as against or across it. Another paper of considerable interest before the Mathematical and Physical Section was one by Professor Schuster discussing the relative importance of collecting observations in a science such as meteorology and of deducing laws from them. Before the Chemical Section the subjects which seem to have attracted special interest were the action of enzymes and the aromatic compounds. Papers before the Zoological Section were presented by Professor Poulton and others on mimicry, and by Professor Herdman on his expedition to study the pearl oyster beds in the Gulf of Manaar, and on the plans for protecting the North Sea fisheries. The Sections of Economics, Geography and Anthropology usually attract the greatest general interest, but space does not permit reference to the papers and discussions. A word should, however, be said in regard to the Section of Education, established last year, which bids fair to become one of the most attractive departments of the Association, setting a model which the American Association should follow.

The attendance at the meeting was 1,620 as compared with 1,951 at the Belfast meeting twenty-eight years ago. The decrease in attendance was not, however, due to fewer scientific men being present, but to a smaller local interest in the meeting. One of the most interesting features of the general meeting was the invitation presented by Professor Charles S. Minot, last year president of the American Association, asking as many members as possible to attend the Washington meeting of the American Association. Professor Minot described the steps that have been taken in America to secure the reorganization of scientific societies under the auspices of the American Association and the securing of a convocation week in mid-winter for the meetings. President Dewar, in replying on behalf of the Association, emphasized the importance of a visit to America, and expressed the hope that there would be a large attendance of English men of science at the meeting to be held at Washington beginning on the Monday after Christmas.

The meeting of the British Association next year will be at Southport under the presidency of Sir Norman Lockyer, one of the most prominent of living astronomers and editor of *Nature*. The meeting in 1904 will be at Cambridge, where efforts will doubtless be made to rival the important meeting at Oxford in 1894. Plans are being made which may lead to a meeting in South Africa in 1905, the colonies having offered to defray a large part of the expenses of delegates.

THE DISTRIBUTION OF ANTHRACITE COAL.

Anthracite differs from ordinary or bituminous coal in that it contains a

small percentage of volatile combustible matter. Commercial anthracite varies from the hard, dry Lehigh with little more than one per cent. to the easily lighted Bernice coals of Sullivan county, Penn., with ten per cent. The Lackawanna and Lykens Valley coals, so much prized for domestic use, are midway between Lehigh and Bernice. The use of hard coal has become so well-nigh universal in the eastern towns and cities that one hardly understands how the community could become accustomed to the use of soft coal; yet the available supply of anthracite in America is so small that, unless some other fuel be discovered, the use of bituminous coal must prevail within seventy-five years at the most. The anthracite fields of Pennsylvania will be exhausted within seventy-five years, even though the annual production should not exceed that of 1901—which is improbable. There is no other deposit of anthracite in the United States, aside from some wholly unimportant patches in North Carolina, New Mexico and Colorado, so unimportant that all combined would yield hardly enough for one year's consumption. Europe has very little anthracite. Most of the Welsh coal is bituminous, the anthracite of the South Wales field being confined to the western end of that field. The Worm basin of Prussia yields perhaps 2,000,000 tons per annum of a semi-anthracite; near Ostrau in the Silesian field and in the Donetz field of south Russia anthracite occurs in moderate quantities; but these are all unimportant. China, however, has vast fields compared with which our Pennsylvania fields are mere dots on the map; there being upward of 40,000 square miles underlain by anthracite coals in Hunan, Honan and East Schansi.

BORAX AS A FOOD PRESERVATIVE.

THE question of the use of borax and boric acid as food preservatives has attracted much attention of late, especially in Germany, where it has been brought forward as a convenient lever to exclude American food products. The results of different investigators are far from uniform, and the conclusions drawn as to its use are correspondingly at variance with each other. It is generally conceded that as far as regards digestion neither borax nor boric acid have any specific influence, but when considerable quantities are present the alkalinity of the former or slight acidity of the latter may be of some effect. In a similar way they may act as mild irritant poisons, occasioning diarrhœa. With continued use most observers find a loss of weight, which seems to be due to loss of fat in the body, and this may occur, without any symptoms of ill health, when small quantities of borax or boric acid are ingested daily. It is possible that this result might attend the regular use of food products which have been preserved by boric acid. While the quantity of the acid present is usually quite small, it is completely eliminated from the system rather slowly. In doses of three grams, one half was eliminated in the first twelve hours, but from five to nine days were required for the disappearance of the remainder. In this way boric acid might have the effect of a cumulative poison. It is said to be a common practice in this country to preserve butter and meat by packing in a mixture of salt with some borax or boric acid. Such a mixture was the 'rex magnum' largely sold fifteen years or so ago. Recent experiments by Polenske show that fat takes up very little of the borax powder, while meats take up no inconsiderable quantity. American pork was found in one case to have absorbed in its outer portion no less than two per cent. of its weight of borax, while in another case four per cent. was taken up in three weeks. This latter amount may, however, be considered extreme. In this connec-

tion an observation of von Lippmann's is of interest. On investigating a deposit in a vacuum apparatus for concentrating lemon juice, he found quite a quantity of boric acid, and on further examination discovered that boric acid is present in small quantity in most fruit, as in lemons, apples, etc. As a result it cannot be inferred, because boric acid is found in preserved or dried fruits, that it has been added as a preservative. Altogether it must be said that the whole matter needs further study, and that it must be determined to what limit the use of boric acid and borax is permissible without endangering health.

SCIENTIFIC ITEMS.

WE record with great regret the death of John Wesley Powell, director of the Bureau of American Ethnology and formerly director of the U. S. Geological Survey. His death occurred at his summer home in Maine on September 23, he being in his sixty-ninth year. There was published in the POPULAR SCIENCE MONTHLY for January, 1882, an article reviewing Major Powell's life and work, illustrated by a portrait, and we hope to publish in the next number a further appreciation of his work.—We regret also to record the death of Sir Frederick Abel, known for his important researches on explosives, and of Dr. John Hall Gladstone, known for his researches on chemical combinations.

DR. CHARLES S. MINOT, professor of histology and embryology in the Harvard Medical School, was given the degree of Doctor of Science at Oxford University, on the occasion of the tercentenary of the Bodleian Library.—Professor W. H. Welch, of the Johns Hopkins University, delivered the Huxley lecture before the Charing Cross Hospital on October first.—Dr. Andrew D. White, Ambassador to Germany, has presented his letters of recall. His successor, Dr. Charlemagne Tower, is also interested in literary and scientific subjects.—An expedition from the Liverpool School of Tropical Medicine under Major Ronald Ross has gone to the Suez Canal to institute preventative measures against malaria.

A COMMITTEE has been formed for the erection of a public memorial of the late Professor Virchow in Berlin, with Professor Waldeyer as chairman.—A monument, consisting of a pedestal and a bust by the sculptor, Marqueste, is to be erected in the Paris Museum of Natural History, in memory of Alphonse Milne-Edwards.—The eightieth birthday of John Fritz, ironmaster and inventor, of Bethlehem, Pa., will be celebrated by a dinner given in his honor on October 31. The dinner will also signalize the founding of the John Fritz gold medal for achievement in the industrial sciences, the medal to be awarded annually by a committee of members of the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institute of Mining Engineers and the American Institute of Electrical Engineers. The organizing committee having the matter in charge on behalf of these societies has already raised $6,000, representing the contributions of some 500 members of the engineering professions in this country and in Europe. The medal has been entrusted to the American sculptor, Victor D. Brenner.